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A CASE OF REMUNERATIVE EXPENDITURE.

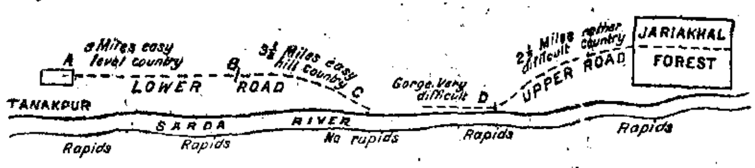
BY J. V. COLLIER, I.F.S.

There are evident signs that increasing interest is being taken in Indian forests, and that their potentialities are at last becoming recognized. The object of this short note is to present one concrete instance of the immediate response of forest expenditure to forest revenue, and to draw the moral that administrations may recognize, in forests, perhaps their most profitable field for investment.

2. The Sarda river forms the eastern boundary of the Haldwani Forest Division of the United Provinces and also the boundary between these provinces and Nepal. The river enters the plains through a very steep and narrow gorge which is about two miles in length and is too precipitous to contain any valuable forest growth. But, above the gorge, the valley opens out into a broad *dun* which contains some excellent Sal forest, sound trees being found up to 16 feet in girth. The finest forest is called Jariakhal and was enumerated in 1885, with the object of exploiting it in the near future. But it was not until 1915 that the first steps were

taken to solving and facing the expenditure necessary to overcome the great extraction difficulties in the way of realizing the full value of the mature stock.

3. The following sketch illustrates the topography of the country :—



The problem was how to bring down sawn Sal timber from the Jariakhal forest to the rail-head at Tanakpur at an extraction cost which would enable Government to realize for itself at least twelve annas per sawn c. ft. in the forest. Until the project with which this note deals was completed, the cost of inevitable coolie carriage was so high that contractors could have only afforded to pay Government the wretched royalty of two annas per c. ft.

Continuous floating was out of the question, as the river is very powerful and full of rapids over almost the whole of the lead. Sal timber will not float and, lashed to dug-outs, would not weather the rapids without great loss. But, in the lower half of the section CD, there is a calm and gently flowing stream, ideal for floating. As the road cost in this gorge section was certain to be very high, it was decided that the timber should be floated down lashed to dug-outs over this mile, and the project was reduced to the construction of two cart-roads (*a*) Tanakpur station up to water's edge at the bottom end of the gorge, and (*b*) from water's edge at a point half way up the gorge to the end of the Jariakhal forest, the two roads to be connected by a six-foot path. The former is called the lower Sarda Valley road and the latter the Upper Sarda Valley road. When the war is over, there is no doubt that the path will be widened to cart-road width, but under present circumstances and considering the cheapness of the floating it would not have been justifiable to build a road except where it was necessary.

4. There was nothing interesting about the lower road from A to C which was constructed in 1915-16. Three and a half miles

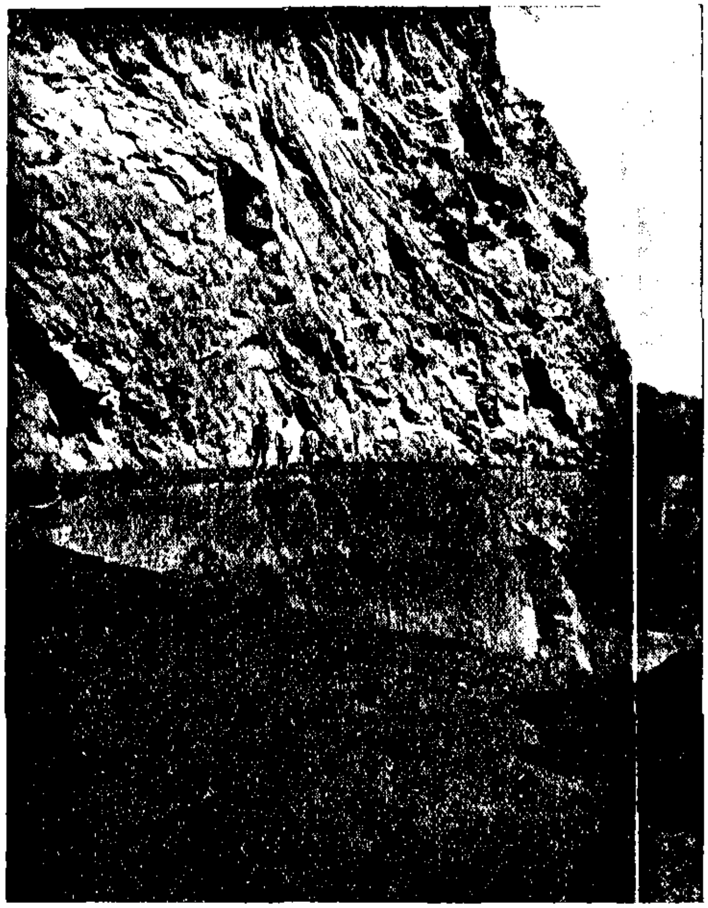


Fig. 1.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2—Upper Sarda Valley road, Haldwani Forest Division.

of 14 feet road were constructed in the hilly country (B to C) with moderate slopes at a cost of Rs. 1,954 per mile. With good walling this was probably a fair average rate. It was on the upper road that difficulties were encountered. The chief obstacle was a high cliff at the top end of the gorge across which the road had to pass, as there was an obligatory point in a bridge site some thirty chains beyond it. The cliff was some four chains in length and rose sheer from the river to a height of 450 feet. Neither grass nor shrubs could find on it any foothold, for it was simply a wall of rock across which the road had to pass at its median line. Figs. 1 and 2 in Plate 1 give some idea of the nature of the obstacle, which had discouraged any previous idea of constructing a road. Expert advice was sought in the first place and, acting upon it, it was decided to cut the road across the cliff in the shape of a half tunnel. This attempt, always attended with risk, resulted in a fall of rock, which killed fourteen coolies. The accident was a case of familiarity with danger breeding contempt of it. The half tunnel had been almost completed and it was only necessary to blast away certain projections. Although the strictest orders had been issued that more than five charges should never be fired simultaneously, it transpired after the accident that no fewer than thirty charges were fired simultaneously forty minutes before the collapse of the roof of the tunnel. Within half an hour of the explosion of the charges, sixty coolies were at work clearing away the débris. It was a very hot March day and, about a minute before the fall of rock, the great majority of the coolies left the cliff to get a drink. They had just got clear when some five hundred tons of rock collapsed on the heads of those who had remained behind. Death must have been instantaneous in every case. This accident was most unfortunate, as it followed on the killing of two coolies by a man-eating tiger which was continuously haunting the labour camps, and rendering the retention of labour a matter of very great difficulty. To make matters worse, there had always existed, in the hills, a strong belief that this particular cliff was sacred, being the foot of a goddess which sat at the top of the gorge

guarding the broad valley beyond. It had been difficult enough to obtain labour in the first place, but this accident, taken in association with the tiger, left no doubts in the minds of the hill coolies that both were manifestations of the displeasure of the goddess at the mutilation of her foot. From the moment of the death of their fellows, the hill coolies abandoned work on the cliff, and even refused to take a hand in removing the débris of the fall. But eventually Afghans were procured and, the half tunnel cutting being abandoned as unsafe, the long and arduous task of cutting out, in full cutting, a 14-feet road from the top of the cliff was commenced. This work was happily completed without accident. Plate 1 (Figs. 1 and 2) shows the completed road across a part of the cliff. Cut out of the solid rock, the road is of course proof against anything except an earthquake. It is full 14 feet in width and will be strongly fenced. The height of cutting was approximately 225 feet and the distance from the road surface to the river is the same. A rate varying between Rs. 30 and Rs. 40 per thousand c.ft. was paid for the rock-cutting and Rs. 9 per hundred for the walling which is in lime.

5. Thus this cliff which had guarded the virginity of the forests above it for so long was effectually dealt with. Beyond it lay a mile of difficult country (Plate 2, Fig. 3), but easy compared with the above section. A side stream was crossed by a Sal truss bridge pictured in Plate 2, Fig. 4. The bridge consisted of eight Sal truss beams 9" × 9" and twelve Sal longitudinal beams 12" × 9", the trusses and longitudinals being braced together by cross-beams and iron tie-rods. The span is 64 feet, almost the maximum span over which wooden truss bridges can be constructed with safety. The bridge is designed to carry elephant and loaded timber-carts and cost Rs. 2,500, the cost being greatly increased by the fact that iron was difficult to procure and the construction was delayed till the hot weather when labour is very expensive. Constructed in the cold weather, it would have only cost Rs. 2,000.

6. Both the upper and lower roads and the connecting path are now completed, and the writer will end this note by a few remarks as to the cost of the road and the resultant revenue.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 3—Upper Sarda Valley road, Haldwani Forest Division.

Fig. 4—Sal truss bridge 64′ Span. Upper Sarda Valley road, Haldwani Forest Division.

The lowest section A-B ran through level country and the total cost was Rs. 150 or Rs. 30 per mile.

In the hilly country the cost was as follows :—

	Length. Miles.	Cost per mile. Rs.
The lower road ...	3½ ...	... 1,954
Upper road ...	3½ ...	... 9,142
Average cost per mile ...	...	... 5,550

The great difference in cost is of course due to the difference in the character of the cutting. On the lower road, the cutting was on moderate slopes with a soft rock or earth mixed with boulder formation. On the upper road, there was a large proportion of heavy rock-cutting and there was also the great cliff obstacle which absorbed Rs. 10,000, itself. The average cost was somewhat over Rs. 5,000 per mile, and the writer thinks that this is a fair average rate for hilly country with an equal proportion of hard and soft cutting. All walling was of first class quality, as the writer believes that cheap walling is the most false ecomony, such walls invariably falling in the rains and requiring to be rebuilt each year. The walls figuring in Plate 2 (Fig. 3) should stand for many years, the high wall (60 feet in height) being built in lime throughout. Comparison is often made between the cheaper road work of the Forest Department and that of the Public Works Department, but it is often forgotten that the walling work of the latter is always incomparably superior to our own. On most of the forest hill-roads with which the writer is acquainted, the walling is done at half the ordinary Public Works Department rate but falls regularly every year and, in five years, has cost considerably more than the better constructed and more expensive Public Works Department wall. But the great difference between Forest Department road work and that of the P. W. D. is that, on the former, a large number of petty contractors take up the work for small profits; whereas on the latter, there are usually several big contractors who employ these petty contractors under them. Thus, on forest works, far less profit is required or made.

7. The total cost of the road has been approximately Rs. 40,000. The road was completed in 1916-17, and in 1917-18 the first felling, yielding approximately 1,25,000 c. ft. will take place. Without a road the utmost value to Government would be 2 annas per c. ft., whereas at least 12 annas will now be realized. Thus the road will reap a profit of approximately Rs. 78,000 in the year following its completion, repaying the cost of construction and yielding a hundred per cent. profit of nearly Rs. 40,000. During the first twenty years' period, the revenue from the valley will not be less than Rs. 4,00,000, *i.e.*, Rs. 20,000 per annum. From this should be deducted the annual cost of upkeep of the road which will be approximately Rs. 2,000, leaving a net surplus revenue of Rs. 18,000 per annum, or a net annual return of 45 per cent. on the initial cost of the road. Thus the resultant revenue is a splendid return on the cost of road construction, and yet it took no less than thirty years before any steps were taken to effect such an excellent investment, while in the meantime large sums were borrowed to finance canal projects in the expectation of a return of seven per cent. The moral is obvious and is doubtless applicable to every province.

LOANS *VERSUS* EXPENDITURE FROM CURRENT FOREST REVENUE IN BURMA.

Some few months ago, Conservators in Burma were asked to submit proposals for expenditure on works of development for which loans might suitably be raised.

The question of the general suitability of financing forest requirements in the province by means of loans, therefore, appears to be worthy of discussion.

I have no pretensions to any knowledge of finance generally, but I take it, that the main argument in favour of raising a loan to finance a forest project, as against financing the same from current revenue is that, more often than not, the benefit to be derived from the carrying out of the project will only accrue to the next—or possibly even to the second—generation, and that, therefore,

it is fairer to distribute the expenditure to be incurred in such a manner as to involve as light a burden as possible on the present generation. There are, however, other points to be taken into account.

In the first place, it is, in existing conditions, practically impossible, in Government service, to keep accounts extending over a series of years showing exactly the profit or loss made on any big item of importance such as would be kept by any business firm. The present system of keeping accounts is not adapted to doing so. The actual profit or loss made on the investment is, therefore, difficult to assess. Again, even supposing that the Government of India sanctioned the principle of raising loans, a considerable time must elapse before the money could be made available. This is not a very strong objection and might, perhaps, not arise when a definite system for doing so had been evolved.

The case for the financing of forest development out of current revenue is a very strong one. A forest property differs from any other estate such as rubber or tea, in that it has been acquired with a large proportion of its maximum possible stock already existing, whereas the planter has to create his *ab initio.* In other words, the great majority of forests in Burma are in a position to produce, at least temporarily, a very handsome dividend without further expenditure being incurred on them from the moment they are acquired.

Now, since this capital has been found by Providence without the existing generation having provided one iota towards it, it is obviously unjust to the future generation that the present one should reap too largely where it has not sown. In other words, it is up to us to put back a fair proportion of the vast property we have been given free, in order to develop and increase its paying capacity for our successors, in place of handing it on to them in a damaged and depreciated condition. The question of what is a fair proportion is open to argument, but it is, I think, entirely unjustifiable that Burma, which has an infinitely more valuable property than any other province in the empire, should spend a lower proportion of its earnings on its development. Curiously

enough, the very fact that these forests contain a large quantity of teak—a more valuable tree than most others—has been used as an argument that it is unnecessary for Burma to spend such a high proportion of her gross revenue as do other provinces. This theory is tantamount to using the high value of a property as a reason against the necessity of its rapid development. It is the more untenable in view of the fact that past experience has shown that every increase in expenditure has produced a more than corresponding increase of revenue. Moreover, for the argument to carry any weight at all, it would be necessary to show that the property is producing a higher return *per acre* than the so-called less valuable teakless estates. Owing to the fact that the vast area of unclassed forest which contributes largely to the gross revenue of the province is unknown, it is unfortunately impossible to quote figures with regard to this point, but available facts all go to prove that the *revenue return per acre of forest* from *Burma is among the lowest—if not the very lowest*—of that received from any other province. This position of an estate which claims to possess the most valuable forest crop is hardly in keeping with the theory enunciated above. Then what about the vast areas of forest which contain no teak, and which have hitherto hardly been considered worthy of reservation? These in themselves form a forest estate exceeding in potential value the entire area under forest in several other provinces. But so far little or nothing has been spent in their development.

There is, moreover, another respect in which forest revenue and expenditure differ to a considerable extent from that of any other industries. It is an accepted fact, that every rupee of forest revenue represents an equivalent income to the pocket to the local population which earns it by felling, logging, carting and so forth. With the exception of the proportion of the expenditure incurred on the European staff (some of us wish it were greater!) almost the whole of this also goes straight into the pockets of the people, and, moreover, enables them to earn considerable sums at the very time when climatic conditions prohibit any work on field crops being done. A much larger proportion of the forest, as

compared with other industrial expenditure, is, therefore, promptly re-invested in the country, and mainly benefits classes of persons who frequently never come in contact with any other means of earning anything. Forest expenditure may, therefore, be regarded as a valuable addition to the welfare of the country.

Turning to facts, the following are the actual figures of gross revenue and expenditure made and incurred in Burma during the last quinquennium, reviewed by the Government of India, as compared with the most important forest-producing provinces of India :—

Province.	Average gross revenue for 5 years, 1909-10 to 1913-14.	Average expenditure for 5 years, 1909-10 to 1913-14.	Percentage of expenditure to gross revenue.
	Rs.	Rs.	
Burma	1,03,48,722	40,14,213	39
Bengal	13,17,448	6,48,342	49
United Provinces	29,90,443	14,67,239	49
Punjab	12,30,935	7,78,359	63
Assam	13,62,349	9,32,009	68
Central Provinces and Berar ...	26,20,137	17,82,926	68
Madras	41,08,101	32,13,323	78
Bombay	43,80,425	24,16,055	55

These figures show that the percentage of revenue to expenditure varies from 78 per cent. in Madras to 39 per cent. in Burma while the average expenditure of the eight principal provinces cited amounts to 54 per cent. of their gross revenue. In face of these figures, it can hardly be argued that the richest forest province is developing its estates as fast as provinces containing forests of far inferior value. Indeed, its low state of development was criticised by the Government of India in its review of the Provincial Forest Administration Report for 1915-16. And why is there any necessity for raising forest loans? All that Burma requires is a fixed policy to expand her annual forest expenditure up to, say, 60 per cent. of her

gross revenue. Such a policy would provide for all the wants of the forests both in increase of establishment and in works of improvement for the next 20 years at least. It would secure an estate of ever-increasing capital value, and yielding an ever-increasing surplus, amounting to 40 per cent. more than the annual gross expenditure per annum even during development. It would, moreover, provide for steady and consistent annual expansion, with a fair incidence of expenditure on both present and future generations. Surely, such a healthy condition of affairs should satisfy the most exacting man of business even in a country which expects such high commercial profits as does Burma! The necessity of a young country having to spend large sums on the development of other industries which do not start with a ready-made capital is evident. Such are obvious instances in which the policy of financing by means of loans is a sound one. But why should the *Forest Estate*, which is a highly paying concern, be asked to borrow money, when its profits, of which a very much larger proportion should be devoted to its own development, are being used to finance other departments or industries in less fortunate circumstances? Such a policy is a striking instance of robbing Peter to pay Paul!

PETER.

COMPARATIVE YEARLY VOLUME-INCREMENTS OF CERTAIN INDIAN TREE-CROPS.

BY R. E. MARSDEN, SILVICULTURIST.

A note on the comparative yearly volume-increments of a few Indian tree-crops which have been measured up may be of interest.

In many *cases the increments are calculated only from* a single period of five years and so cannot lay claim to accuracy ; in other cases, when the age is entered, the increment is calculated according to this known age. In all cases, the method of volume-calculation is by the quarter-girth-squared.

Species.	Age.	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Shorea robusta	26	Gorakhpur ...	472	84
Do.	60	Bareilly ...	100	78
Do.	28	Jalpaiguri ...	1,142	94
Do.	33	Do. ...	650	89
Do.	50	Do. ...	218	74
Do.	52	Do. ..	218	80
Do.	60	Do. ...	156	68
Do.	73	Do. ...	89	58
Do.	...	Siwaliks ...	513	57
Do.	...	Do ...	608	91
Do.	...	Bahraich ...	738	146
Do.	...	Do. ...	580	73
Do.	...	Do. ...	170	44
Do.	...	Kheri ...	1,707	114
Do.	...	Do. ...	86[illegible]	67
Do.	...	Do. ...	636	109
Do.	...	Do. ...	305	104
Do.	...	Do. ...	216	113
Do.	...	Haldwani ...	1,104	66
Do.	...	Do. ...	317	80
Do.	...	Do. ...	148	101
Do.	...	Pilibhit ...	426	43
Do.	...	Gonda ...	1,142	91
Do.	...	Do. ...	402	89
Do.	...	Do. ...	224	50
Do.	...	Do. ...	146	164

Species.	Age.	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Shorea robusta	...	Gonda ...	143	102
Do.	...	Do. ...	64	187
Dalbergia Sissoo	32	Gorakhpur ...	98	62
...	...	Siwaliks ...	1,487	124
Pterocarpus santalinus ...	52	Cuddapah ...	218	33
Bucklandia populnea ...	38	Darjeeling ...	325	162
Eucalyptus Globulus Coppice...	5	Ootacamund ...	...	792
Do. do. ...	6	Do. ...	...	660
Do. do. ...	7	Do. ...	...	815
Do. do. ...	8	Do. ...	...	732
Do. do. ...	19	Do. ...	...	729
Do. do. ...	25	Do. ...	...	860
Eucalyptus Globulus High Forest.	30	Do. ...	...	474
Do. do. ...	30	Do. ...	...	527
Do. do. ...	40	Do. ...	...	496
Duabanga sonneratioides ...	3	Darjeeling ...	647	144
Do. ...	6	Do. ...	217	206
Do. ...	10	Do. ...	209	329
Tectona grandis	8	Nilambur ...	611	157
Do.	8	Do. ...	540	104
Do.	8	Do. ...	518	95
Do.	8	Do. ...	486	174
Do.	10	Do. ...	626	91
Do.	10	Do ...	545	82
Do.	11	Do. ...	...	117
Do.	14	Do. ...	...	91

Species.	Age.	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Tectona grandis	15	Nilambur ...	...	65
Do.	20	Do. ...	...	96
Do.	24	Do. ...	...	67
Do.	50	Do. ...	...	55
Do.	68	Do. ...	...	51
Do.	11	Tinnevelly ...	800	125
Cinnamomum Camphora ...	19	Experimental Garden, Dehra Dun.	561	156
Morus alba	6	Changa Manga ...	2,350	136
Do.	16	Do. ...	...	142
Casuarina equisetifolia ...	3	Chingleput ...	1,060	100
Do. ...	5	Do. ...	650	116
Do. ...	6	Do. ...	780	200
Do. ...	7	Do. ...	1,360	204
Do. ...	8	Do. ...	675	240
Do. ...	9	Do. ...	515	171
Do. ...	11	Do. ...	850	146
Do. ...	12	Do. ...	400	132
Do. ...	14	Do. ...	620	143
Betula cylindrostachys ...	9	Darjeeling ...	250	84
Do. ...	30	Do. ...	174	217
Alnus nepalensis	10	Do. ...	547	103
Quercus semecarpifolia ...	...	Chakrata ...	1,269	93
Do. ...	...	Do. ...	815	92
Quercus incana	...	Almora ...	1,567	142
Do.	...	Do. ...	1,017	75

Species.	Age.	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Quercus incana	...	Bhowali ...	1,020	71
Do.	...	Do. ...	718	104
Do.	...	Do. ...	311	109
Do.	36	Experimental Garden, Dehra Dun.	525	112
Quercus dilatata	...	Naini Tal ...	3,328	155
Do.	...	Do. ...	2,180	122
Do.	...	Do. ...	1,575	182
Do.	...	Do. ...	1,467	113
Do.	...	Do. ...	650	232
Pinus excelsa	34	Ranikhet ...	540	145
Do.	35	Chakrata ...	788	194
Do.	38	Do. ...	625	145
Do.	50	Chamba ...	1,045	53
Do.	50	Do. ...	1,490	65
Do.	73	Do. ...	642	78
Do.	83	Do. ...	392	106
Do.	92	Bashahr ...	244	117
Pinus longifolia	12	Almora ...	1,947	46
Do.	15	Do. ...	1,650	55
Do.	19	Do. ...	2,200	90
Do.	23	Naini Tal ...	2,274	140
Do.	28	Do. ...	700	67
Do.	28	Dehra Dun ...	333	69
Do.	32	Chakrata ...	1,625	99
Do.	35	Do. ...	1,304	91

Species.	Age.	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Pinus longifolia	34	Naini Tal ...	473	102
Do.	34	Experimental Garden, Dehra Dun.	322	239
Do.	36	Almora ...	1,220	30
Do.	36	Do. ...	436	66
Do.	44	Naini Tal ...	397	82
Do.	45	Dehra Dun ...	96	136
Do.	48	Bhowali ...	969	76
Do.	48	Naini Tal ...	397	82
Do.	48	Rawalpindi ...	290	49
Do.	54	Almora ...	293	86
Do.	55	Naini Tal ...	236	104
Do.	67	Rawalpindi ...	201	73
Do.	75	Do. ...	198	58
Do.	85	Do. ...	65	50
Do.	112	Do. ...	98	42
Do.	135	Do. ...	56	42
Cedrus Deodara	34	Ranikhet ...	605	103
Do.	34	Do. ...	645	178
Do.	37	Chakrata ...	915	249
Do.	37	Do. ...	2,215	437
Do.	51	Do. ...	745	124
Do.	51	Do. ...	680	202
Do.	51	Bashahr ...	268	134
Do.	60	Chakrata ...	232	340
Do.	65	Do. ...	417	273
Do.	90	Do. ...	334	266

Species.	Age	Locality.	No. of stems per acre.	Annual increment (solid cub. ft.) per acre.
Cedrus Deodara	167	Bashahr ...	90	138
Do	368	Do ...	111	56
Abies Webbiana	115	Darjeeling ...	481	60
Do.	151	Do. ..	286	74
Cupressus torulosa ...	31	Ootacamund ...	263	241
Tsuga Brunoniana ...	38	Darjeeling ...	1,558	131
Do. ...	46	Do. ...	586	120
Do. ...	49	Do. ...	655	156
Do. ...	49	Do. ...	1,392	137
Do. ...	247	Darjeeling ...	165	72
Cryptomeria japonica ...	22	Do. ...	704	300
Do. ...	24	Do. ...	119	100
Do. ...	28	Do. ...	104	115
Do. ...	31	Ootacamund ...	322	160
Do. ...	50	Darjeeling ...	157	258

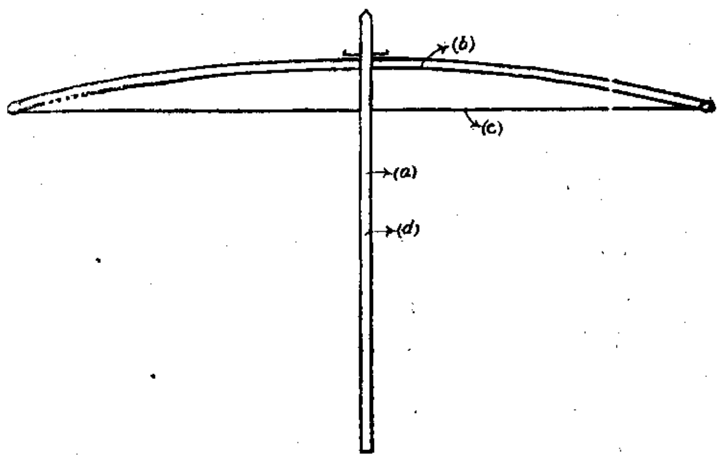
Best European figures (Volume calculated by πr^2 method).

	Age.	M. A. I.
Pseudotsuga Douglasii	32	117
Do.	45	197
Pinus sylvestris	20	122
Do.	60	155
Picea excelsa	70	237
Abies pectinata	110	240
Fagus sylvatica	110	152
Quercus robur	80	129
Larix europæa	60	130
Do.	100	121
Alnus glutinosa	50	96
Do.	100	91
Coppice of Alder, Poplar, Willow	40	113
Coppice of Oak, Beech, Ash, Birch	40	70

TIMBER OF PETTHAN (*HETEROPHRAGMA ADENOPHYLLUM*, SEEM.).

BY A. J. S. BUTTERWICK, P.F.S.

One of the chief weapons of offence amongst the Burmans is a sort of cross-bow, called "laydu," a rough sketch of which is given below :—



(*a*) is the staff called "too." It is made from the heart-wood of Thabutgyi (*Miliusa velutina*), and is generally about 3′ to 3½′ long by 2½″ broad and 1″ thick. Into this staff, 5″ from one end, is tenoned (*b*) the bow, called "layphyin" which is fashioned from a bit of the heart-wood of Petthan (*Heterophragma adenophyllum*). This is 4′ 9″ to 5′ 6″ long, 1½″ or 2″ broad at the centre, tapering down to ½″ at the two ends, and ⅞″ thick. At the ends of the bow are shallow notches, on to which is firmly fastened a strong cord (*c*) made of plaited Shaw (*Sterculia* spp.) fibre. The cord is pulled until it is held up by (*d*) a sort of trigger made very ingeniously of any hard wood. This trigger is placed 1′ 3″ from the junction of the staff and bow. A bamboo arrow 1′ 9″ long, pointed at one end and winged at the other is placed, in a long shallow groove made along the top of the staff just above the trigger, and is shot by simply pulling the trigger down and thus releasing the tautened Shaw rope. The writer has taken a great interest

in these cross-bows and has examined over a hundred of them in the Pyinmana Division. The jungle Burman or Karen is quite *au fait* in its use, and, in his hands, a considerable amount of damage can be done to monkeys, squirrels, birds, and other small game. It is believed that, in some parts of Burma, this cross-bow is also used to shoot "thamin" deer and "gyi" (barking deer), but the writer cannot authenticate this. It is, however, the principal weapon of defence amongst the jungle cultivators against marauding elephants. The sharp-pointed arrows penetrate about three inches into the flesh of these huge pachyderms and appear to give them no small amount of pain, judging from the loud trumpetings, which they emit after they have been so hit. The writer has seen an arrow fired on a still day from one of these weapons travel well over 120 yards before it dropped. He has also seen an arrow fired from about ten yards away penetrate 2½ inches into a young teak tree. From the above it will be seen that the Petthan bow, which gives the arrow the force and impetus to travel so far and so quickly, must possess an extraordinary amount of strength and elasticity. The Burmans and Karens in the Pyinmana Division prefer it to any other wood. They allege that Shah (*Acacia Catechu*) is as good as Petthan, in the rainy and cold weathers, but is very apt to snap in the hot weather as it gets too dry. Besides it is far too heavy. They will not look at such hitherto well-known elastic woods as Petwun (*Berrya ammonilla*) and Tayaw (*Grewia* spp.), as they state that such woods will not bear the strain. The way they prepare the Petthan bow is very simple and is as follows. The bow is cut from the heart-wood of a green tree. When first cut, the colour is a yellowish white but, after exposure to the air, it becomes an orange red. After cutting, the implement is carefully fashioned with a dah, smoothened with a plane and sand-paper, and thoroughly earth-oiled. It is then tied down at both ends over some prepared convex surface so as to take the required curve. It is kept like this for a week or ten days until set, and is then ready for use. By that time it is dark red in colour. A good Petthan bow, which is kept earth-oiled every year, is said to last over fifteen years.

Petthan is a very little-known wood and, with the object of making it better known, the writer has ventured to publish these few notes. In his humble opinion, the wood is worthy of serious attention, especially in these days when a strong elastic timber is required for the construction of aeroplanes. Petthan appears to be admirably adapted for this purpose as well as for camp furniture. The tree, which has a very fine appearance, occurs sporadically in ordinary teak deciduous forests. It grows a fine clean straight bole, and specimens over seven feet in girth have often been found. It is common in the Pyinmana Forest Division and, it may be assumed, it similarly occurs thoughout the whole of Burma. Gamble gives the weight per cubic foot at 42 lbs., and it appears, therefore, to be as light as teak. In his *Manual of Indian Timbers*, Gamble gives the following information on this timber, which the writer quotes verbatim as it is worthy of note :—

"Wood: sap-wood light yellow ; heart-wood orange-yellow, with occasional darker streaks, moderately hard to hard. Pores moderate-sized, ringed, filled with yellow resinous matter, uniformly distributed, but occasionally running into more or less concentric lines. Medullary rays fine to moderately broad, the distance between them equal to or greater than the diameter of the pores, giving a good silver-grain.

"Upper mixed forests in Burma and the Andaman Islands ; often cultivated in Indian gardens. Prain says it is common in the Cocos Islands.

"A handsome tree, with large leaves and large brownish-yellow flowers. The wood is well deserving of being better known, and becoming possibly, if the tree is sufficiently common, an export timber. Ferrars (Andamans List, Calcutta Exhibition, 1883-84) says that it does not warp or split, and is excellent for cabinet-work. It is not clear whether it can be obtained in large size or not ; at any rate, this should be investigated. Ferrars' specimen gives W = 52 lbs.

B 1421. Tharrawaddy, Burma......42 lbs."

IMPORTS OF TIMBER INTO BRITISH INDIA DURING THE YEARS 1912-13 TO 1916-17.

The accompanying comparative statement of imports of timber into India and Burma during the last five years, compiled from figures supplied by the Department of Statistics, wil be of interest to Forest Officers.

The first point which deserves attention is the entry of Japan and the United States into the arena of supply of Deal and Pine. This refers mainly to India, exclusive of Burma, as in the latter country the supply has already reached formidable dimensions and is rising in leaps and bounds.

The importation of Jarrah, on the other hand, seems to be declining rapidly.

Siam and Straits Settlements are supplying more and more "Other Timbers."

India, and more especially Burma, with their wealth of resources in timbers, should not have to import these vast quantities of timber since timbers, at least equally as good, must be available locally, given facilities for exploitation.

Statement showing the Imports of Timber by sea from foreign countries into British India during the years 1912-13 to 1916-17.

Countries of consignment.	1912-13.		1913-14.		1914-15.		1915-16.		1916-17.	
	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.
(i) INDIA EXCLUSIVE BURMA.		Rs.		Rs.		Rs		Rs.		Rs.
DEAL AND PINE.										
Japan	...	...	...	...	...	...	3,643	3,12,013	19,733	23,00,151
United States, America	...	...	...	...	1,410	75,075	1	200	5,699	9,07,067
Other countries	16,997	10,23,536	31,927	20,08,534	5,420	4,95,082	2,491	3,17,748	1,065	1,83,827
Total ...	16,997	10,23,536	31,927	20,08,534	6,830	5,70,157	6,135	6,29,961	26,497	33,91,045
JARRAH	5,861	5,05,683	8,102	6,03,206	7,434	5,76,779	3,218	2,03,100	...	...
TEAKWOOD	28,538	28,75,722	18,641	24,42,565	27,470	38,85,460	22,666	29,07,835	24,477	31,85,744
OTHER TIMBER.										
Siam	1,789	1,19,900	2,367	1,97,574	3,294	3,26,347	4,619	4,65,300	7,727	7,65,273
Japan	92	4,223	67	4,512	544	44,625	1,339	1,38,469	1,180	1,20,128
Ceylon	5,161	1,64,279	5,842	1,91,528	4,124	1,48,362	3,980	1,72,272	3,560	1,35,995

Countries of consignment.	1912-13.		1913-14.		1914-15.		1915-16.		1916-17.	
	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.	Quantity Cubic tons.	Value.
		Rs.		Rs.		Rs.		Rs.		Rs.
Straits Settlements including Labuan	8,723	4,33,108	16,307	9,77,766	13,556	8,08,257	15,096	9,28,523	11,932	9,86,869
United States, Atlantic Coast ...	...	...	...	...	814	37,296	4,333	2,93,483	5,891	8,95,031
Other countries	5,183	3,28,393	6,265	4,73,496	2,953	2,51,927	5,228	5,51,188	2,010	2,30,711
Total ...	**20,948**	**10,49,903**	**30,848**	**18,44,876**	**25,285**	**16,16,814**	**34,595**	**25,49,235**	**32,300**	**31,34,007**
Grand Total ...	*72,344*	*54,54,844*	*89,518*	*68,99,181*	*67,019*	*66,49,210*	*66,614*	*62,90,131*	*83,274*	*97,10,796*
(ii) BURMA. DEAL AND PINE.										
Japan	152	15,507	190	13,733	4,971	76,923	1,670	1,12,663	1,562	1,47,781
Other countries	863	80,607	3,702	3,86,046	2,439	2,60,496	94	14,296	...	...
Total	**1,015**	**96,114**	**3,892**	**3,99,779**	**7,410**	**3,37,419**	**1,764**	**1,26,959**	**1,562**	**1,47,781**
TEAKWOOD	...	...	**19**	**6,207**	**7**	**1,645**	...	...	...	...
OTHER TIMBER	**3,243**	**2,18,778**	**2,719**	**1,58,129**	**2,264**	**1,26,934**	**2,047**	**99,476**	**1,420**	**69,018**
Grand Total ...	*4,258*	*3,14,892*	*6,630*	*5,64,115*	*9,681*	*4,65,998*	*3,811*	*2,26,435*	*2,982*	*2,16,799*

ATLAS PRESERVATIVE: AN AID TO IMPROVEMENT FELLINGS AND GIRDLING.

BY C. W. ALLAN, RETIRED EXTRA-DEPUTY CONSERVATOR OF FORESTS.

I do not think it is generally known to Forest Officers how excellent Atlas preservative is for killing trees of all kinds.

I have tried it on the following :—

Padouk ...	... *Pterocarpus macrocarpus*
Thinbaw koko (Rain tree) ...	*Pithecolobium Saman*
Gulmohur ...	... *Poinciana regia*
Teak ...	... *Tectona grandis*
Myaukchaw ...	... *Homalium tomentosum*
Nyaung ...	... *Ficus* sp.
Lein ...	... *Terminalia pyrifolia*
Didu ...	... *Bombax insigne*
Hnaw ...	... *Adina cordifolia*
Pyinkado ...	... *Xylia dolabriformis*

and many others and have found that it kills the trees in less than a fortnight. The method I adopted was to girdle the outer bark of the trees, not cutting into the bast, and apply the preservative with a brush to the girdle. On the second day the leaves begin to wither, in a week the tree is absolutely bare of leaves, and in less than a fortnight it is quite dead. Soft-wood trees die much more easily than hard-woods. The preservative kills not only the part above the girdle but the roots also, and what is more, it preserves the wood and makes it immune from the attacks of white-ants. I have had the *Pithecolobium Saman* lying on the ground for three years without a white-ant attacking it.

The preservative is excellent for killing epiphytic figs on *Ficus*-bound tree (*nyaungbats*). It is necessary only to cut the bark off the exposed part of the roots or bole of the Ficus, and apply the preservative. The bast draws up the preservative to all parts of the tree and in a very short time the Ficus dies, and in a few months begins to fall off, leaving the host intact and uninjured. A large *nyaungbat* which would take hours to fell or to girdle can be

treated with the preservative in a few minutes, thus saving time and expense.

In many instances it is necessary to kill large soft-wood trees growing over clumps of teak, Pyinkado, etc. If the tree is felled outright, a great deal of damage results, however carefully the tree may be felled. If it is girdled very deep, as must be done in the case of soft-woods and trees with no heart-wood such as *Homalium tomentosum*, *Anogeissus*, etc., it is necessary to cut very deep into the tree, with the result that it falls if a strong wind strikes it, thereby doing damage. If it does not fall, it takes three or four years to die. Treated with the Atlas preservative, it dies in less than a fortnight and the branches fall to the ground gradually, first the very small ones, then the larger and so on. The cover is removed and the young plants, in the interests of which the tree has been killed, get light and come on rapidly. The stronger the preservative applied, the quicker the tree dies. I prefer to use it pure. One gallon will kill many trees. I may here note that when in charge of the Henzada Division I smeared all the book-shelves and almirahs in my office with the preservative and found that not a white-ant came near them.

Deal-wood boxes treated with a wash of the Atlas preservative become absolutely immune to the attacks of white-ants.

On the 26th February 1917 a swarm of honey-bees came into my office in Henzada and settled on one of the book racks that had been smeared with the Atlas preservative some three years before. Mr. B. P. Kelley, Extra Deputy Conservator, came to relieve me of the charge of the Division on my retiring from the department, on the 28th February 1917, and when about to leave the office, I said to Mr. Kelly that I would leave him a legacy in the form of a bee-hive and took him round to show him the bees. To my surprise I found the whole swarm, with the exception of a dozen or so, lying dead on the ground below the spot where they had settled. Those still alive were nearly dead, and died during the night.

GROWTH OF THE PALMYRA PALM.

BY W. McRAE, GOVERNMENT MYCOLOGIST, COIMBATORE.

With reference to a note on page 236 of Vol. XLIII (No. 5 May 1917) of the *Indian Forester* regarding the number of leaves produced by a palmyra in a year, perhaps a note of the record that is being kept on some palmyras on the Government Central Agricultural Station, Coimbatore, may be of interest. Of 13 palmyras numbers 1 to 8 and number 11 are situated on a broad bund between irrigated fields of garden-land, while numbers 9, 10, 12 and 13 are on the side of a farm-road close by. The height in 1917 from the ground-level to the point where the leaf-stalks of the highest (youngest) leaves bend away from one another showing the solid unexpanded or expanding central leaf-blade is given to the nearest foot in order to indicate the kind of trees under observation. The record shows only the number of leaves produced. A zinc label was wired on to the leaf-stalk of the youngest leaf whose leaf-stalk was protruding from the top of the bud. In the succeeding year the same was done. The leaf having the lower label was not counted in the year's count but the leaf having the new label was. This ensured that these leaves were not counted twice. In the case of certain other palmyras not mentioned in the table, where the labels were removed surreptitiously or accidentally more than once, the trees were thrown out of the count.

The actual fixing of the label was done by a coolie-climber under careful direction and supervision.

Number of the palmyra.	Date of first fixing the label.	Dates on which counts were made.					Amount average for 6⅓ years.	Height in feet of the palmyras in 1917.
		14-2-12.	31-3-14.	21-4-15.	14-2-16.	14-6-17.		
1	14-2-11.	17	31	16	17	21	16	41
2	,,	16	32	16	13	18	15	24
3	,,	14	30	15	12	17	14	39
4	,,	17	37	17	14	21	16·5	24
5	,,	14	31	16	13	18	14·5	23
6	,,	14	23	13	10	...	..	...
7	,,	16	30	16	13	20	15	35
8	,,	16	29	15	13	21	15	40
9	,,	12	28	10	11	14	12	13
10	,,	12	28	11	13	15	12·5	13
							annual average for 4⅓ years.	
11	,,	16	Label was not found.	18	14	22	16	37
12	,,	12	Do.	15	14	19	14	13
13	,,	12	Do.	15	13	19	14	12

The average number of leaves that expanded each year on ten palmyras for 6⅓ years and on three palmyras for 4⅓ years was 14.

The rainfall in inches at the Agricultural Station, Coimbatore, for these years was :—

1911.	1912.	1913.	1914.	1915.	1916.	Average.
29·77	31·68	15·73	15·73	28·41	23·08	24·76

EXTRACTS.

FORESTS AND RAINFALL.

There are several questions regarding the mutual relations of natural phenomena that appear at first sight so simple that the obvious answers may be received for generations as too clear to require reconsideration. One of these is the influence of forests on rainfall. It seems so natural that if a large area of bare ground is planted with trees which grow into a forest the moisture of the district will be increased by increasing rainfall, diminishing run-off, and, in hot countries, falling temperature that one scarcely stops to inquire on what evidence the belief is based. Everyone must remember the vivid picture drawn in Marsh's "Man and Nature" *of the desolation wrought in Palestine and other* ***Mediterranean***

lands by dessication consequent on the destruction of forests and abandonment of cultivation. But in that work, as in most of the writings on this and cognate questions, the motto of the discussion might be *post hoc, ergo propter hoc.*

The problem has been attacked by innumerable writers in Europe and America, and we do not profess to have the mass of heterogeneous literature at our finger-ends. We do, however, retain a general impression of unsatisfactoriness in the methods and results, and the impression is renewed by the latest contribution to the subject, the Indian Forest Bulletin, No. 33. This consists of a "Note on an Inquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India," prepared by Mr. M. Hill, Chief Conservator of Forests of the Central Provinces. Mr. Hill has presented an admirable *précis* of what must be a large mass of official documents, and he appends two excellent memoranda by Dr. Gilbert Walker, the Director-General of Observatories in India. That the good work of Mr. Hill should leave an unsatisfactory impression is not his fault but his misfortune in having to deal with official reports instead of plain scientific data. The history of the investigation as set out in the bulletin is briefly this :—

In 1906 Lord Morley, then Secretary of State for India, sent to the Viceroy a note from Dr. J. Nisbet, formerly of the Indian Forest Service, pointing out that "the relation of Forests towards the mitigation of the severity of famines" had never been adequately considered. Sir William Schlich forwarded with Dr. Nisbet's letter his opinion that an investigation of the influence of forests on rainfall would be very difficult and unlikely to lead to any definite result. Nevertheless, the Government of India sent out to all the Local Governments a request that the subject should be inquired into and all available information collected. In due time the Local Governments sent in reports on their own provinces, and these are tersely summarized by Mr. Hill with an admirable neutrality, which, nevertheless, fails to conceal the fact that the reports differed widely in quality. The general result is stated officially as follows :—

"After a careful examination of the replies received from Local Governments, as summarized above, and after consultation with the Director-General of Observatories, the conclusions arrived at by the Government of India were briefly that the influence of forest on rainfall was probably small, but that the denudation of the soil, owing to the destruction of forests, might, as far as India is concerned, be looked upon as an established fact; while as regards the effect of forest preservation on rainfall and the underground water-supply the papers forwarded did not provide sufficient information to justify any change in the principles on which the forest policy of the Government has hitherto been based. It was remarked that these principles were founded mainly on considerations of a directly economic character, connected with the conservation of the grazing resources and forest produce of the country, and that the climatological considerations did not in any way affect these well-established principles."

The Government of India forthwith sent a second series of questions to the Local Governments with the view of ascertaining whether experiments might not be instituted in order to obtain fresh data. These dealt with the local differences within and without forest areas in rainfall, soil water-level, and height and duration of floods. The Local Governments duly prepared and sent in reports which were considered by the Government of India in consultation with the Board of Scientific Advice, and the final decision, expressed in five paragraphs, may be summarized thus :—(1) Meteorological stations in specially selected positions inside and outside forest areas would probably yield valuable results, and "if it be found possible to initiate inquiries of this nature further action would be taken." (2) Observations on soil water-level need not be initiated, as the data would be of little value in showing forest influence. (3) Satisfactory experiments on floods could no easily be undertaken, but the belief that the forests are beneficial in this respect is confident and almost universal. (4) No material change in the forest area of any province seemed to be contemplated, but if such changes should be made the Government of India desired that Local Governments should make efforts to ascertain the

effect of such changes on average rainfall. (5) The system of shifting cultivation, by which large areas of forest are annually destroyed in Native States and elsewhere, should be discouraged.

To our mind the method adopted could produce no better result than it appears to have done. In a scientific problem such as was set forth, the only function of the State seems to us to be to decide that such an inquiry shall be carried out at the public expense, and that every facility for obtaining data shall be given by all the departments of all the Governments concerned, local and central. It should then be handed over to a competent man of science set free from all other duties and supplied with necessary assistants. His report, when complete, would be authoritative and epoch-making, if not final, and incidentally his own reputation would be made or marred by his handling of the facts. The total expense would probably be no greater, and the labour of many public servants would not be diverted from the work for which they were trained.

Dr. Gilbert Walker's contributions on the relations of forests and rainfall are given as appendices, but are deprived of most of their scientific value by the omission of tables and diagrams to which constant reference is made. These, of course, have been published in the Memoirs of the Indian Meteorological Department. Dr. Walker fully grasps the difficulty of the inquiry. He shows that in India, as elsewhere, the annual rainfall has a tendency to run in spells of excessive and deficient years, and that if this fact is neglected totally false conclusions as to the influence of forest growth or destruction could easily be arrived at. He lays stress also on the short period available for comparison on account of the very untrustworthy nature of the Indian rainfall statistics in the earlier years of the work of the Meteorological Department.

Dr. Walker considers that, as Blanford pointed out in 1887, "the only satisfactory evidence would be that obtained by comparing the rainfall of a district when the trees were very few." In our opinion the comparison should not be of a district A at the time t with the same district at the time t'; but to compare the relation of district A to a contiguous district B at the time t with the

relation A to B at time *t*, where A is a district that has undergone a great change as regards forest covering, while B has remained unchanged. The reason for this indirect comparison is, of course, to eliminate the effect of the two periods falling in what Prof. H. H. Turner calls different climatic chapters. Another method would be to determine the relation of the isohyetal lines to the configuration of the land on wooded and treeless districts of similar character. As pointed out in the report on the rainfall, in the Geological Surveys, " Water-supply Memoirs of Hampshire," the district of the new Forest shows a considerably higher general rainfall than its elevation above sea-level appears to suggest. The subject is both fascinating and important, and the time wil no doubt come when increase of accurate observations will enable the belief in the beneficial influence of forests on climate to be supported or corrected by definite meteorological evidence.—[HUGH ROBERT MILL in *Nature*.]

CAPTURING WILD ANIMALS IN THE CENTRAL *PROVINCES*.

BY D. CLOUSTON, M.A., B.SC., DEPUTY DIRECTOR OF AGRICULTURE, SOUTHERN AND WESTERN CIRCLES, CENTRAL PROVINCES.

The Central Provinces and Berar are among the most jungly parts of our Great Eastern Empire. To the *shikar*-loving Englishman, a post there is worth many tiger skins, not to speak of the exciting sport to be had in the bagging of their game, for the forest area is so vast that civilization has not yet driven these denizens of the jungle from their haunts. Nor does the tiger hold undisputed sway in these wilds: panthers, wild buffaloes, bison and bears compete with him for territory, and wild cattle claim as much as they dare. Of these last, not man-eaters it is true, but fierce enough to afford much fun, I propose to write of an exciting experience I had in capturing some particularly fine specimens. They are known as wild cattle now and, as my tale will show, the name is well deserved: *but the type of animal shows that some*

remote ancestors of the existing herds must have been domesticated. The supposition is that daring and untractable spirits have, in times past, strayed beyond the confines of straggling villages and, not wishing or not knowing how to return, have lived and bred in the wilds. It is customary in India among religious devotees in times of stress and of rejoicing to dedicate cows to their gods. The animal, whose good fortune it is to be considered worthy of such distinction, is permitted to roam at large in the village and a theory is held that probably these sacred animals formed the nuclei of some of the existing herds of wild cattle, but this is only speculation. In any case, the forest is now their home by right of adoption, and how to check their ravages has exercised the minds of Government officials in recent years; for, in several districts, these cattle have multiplied so as to become a pest to the village cultivator, whose crops they damage at night. The original trait, which led them away from the shelter of their stalls, has developed abnormally, and they now travel long distances by night in search of food and drink. In the hot season, these arid plains of India afford but few "cool, shady rills," and these cattle, like other inhabitants of the jungle, under the protecting veil of night, leave their haunts and wander thus abroad until they find a pool. This quest usually leads them into the neighbourhood of a village, and the villagers are the sufferers: standing crops are trampled down, and fodder stored in stacks in the villages even is raided at times.

A herd of about seventy of these cattle had long frequented a *babul* jungle near Khamgaon in Berar. In their nightly raids on the crops of the neighbourhood, they had done much damage and the villagers were sorely distressed at seeing their substance depleted year after year. They appealed to Government for assistance: Government in turn issued an order to the Department of Agriculture to see that these cattle were either captured or shot. To shoot them would have been an easy task, but it seemed a pity to take the lives of so many fine animals. It was, therefore, decided to make a bold effort to capture them alive, and, if possible, to tame them for farm work or breeding purposes. With this

end in view, a *kheddah* was constructed in that part of the forest most frequented by the herd during the day. This *kheddah* consisted of a circular area of nearly three acres,* enclosed by a strong eight-strand barbed wire-fence, supported on posts three feet apart. Each post was strengthened by the addition of a strong stay: the fence was still further strengthened from the inside by a thick paling of thorny branches, reaching to a height of seven feet. It was found, however, that the charge of these wild cattle *en masse* was something terrific, and that this formidable barricade was only a trifling obstacle to them. As the whole herd of about seventy had escaped after being enclosed, it was deemed necessary to dig a trench round the inside of the fence which would prevent them, when inside, from rushing the wall of thorns and wire-fencing. Shortly after completing this second line of defence, four bulls, which had been driven out of the larger herd, were beguiled into the *kheddah* by trails of tempting *karbi* (*juar* straw), cotton seed and salt put down outside the gate and leading up to a small stack of *karbi*, which had been placed in the centre of the *kheddah*. One of these bulls was the best of his kind which I have seen in India. All four were of a fine majestic bearing: their alertness and great strength made their capture all the more difficult. Having engaged the services of local men with strong nets, we entered the *kheddah* to begin the sport. Our first appearance was met by a wild protest on the part of the bulls, which, by a sudden charge, made us retreat pell-mell by the gateways or into trees. I had taken the precaution to have two ladders placed against the gate, so that we could, when pursued, escape by that means. On one occasion, a rung of one of the ladders broke under my weight, and a bull was close on my heels before I could get out of his reach. The first day's attempt to entrap them in nets proved futile. This method was full of risks too, for the bulls were oftener pursuing than being pursued by our men, and several men had narrow escapes of being gored before they could get up a tree or escape by a ladder.

On the second day, we decided to lasso them, if possible, by using an ordinary running noose hung on the end of a long thin

bamboo. The men who manipulated these entered the *kheddah* in strong covered carts each drawn by a pair of bullocks. The bulls seemed to regard the cart as being a very formidable object, and at a distance of twelve or fifteen yards, shook their heads at it, but refrained from charging. Protected by the carts, the men aimed at throwing the lasso over their heads. After several attempts we succeeded in lassoing the largest of the four in this way. His rage was unbounded when he felt the rope tighten round his throat; for, with the other end securely fastened to a tree, there was not much chance of escape. The grèat leviathan charged round and round, rearing at times like a horse and bellowing loudly in his fury. It seemed at first as though the tree, visibly swaying, must give way before his great strength. After some time a second lasso was thrown successfully, and the rope firmly fixed to another tree. Between these two trees, he rushed backwards and forwards in his fury, charging at every living thing that came near. Though he made a splendid fight for it, escape was impossible, and at last he rushed madly into one of the nets and fell. In a very few minutes our men nimbly scrambled down from the trees and carts in which they had taken safety, and completed the capture of this fine-looking denizen of the jungle. His legs were securely tied, and in the last scene of the act a strong string was drawn through his nose, for, in anticipation of capture, the classic *hiran's* (antelope's) horn and string had been kept ready. He was at last thoroughly under our control and was securely tied to the nearest tree both by the nose string and by ropes passing round his neck. There he lay at our mercy awaiting the time when he would be taken to the Government Farm near by, where he was to be trained to the yoke.

The second largest bull of the four proved the pluckiest of the lot. At the time of throwing the lasso, our men sometimes ventured too far from the carts, and narrowly escaped injury when they were charged by the bulls. When this particular animal was lassoed, the game became still more dangerous, as he became absolutely infuriated and rushed at every living thing that came within his reach. He caught and gored one man who ventured too

far from his cart, and would, no doubt, have killed him outright, had he not been enticed away from his helpless victim by the shouts of other men in a cart near by. After a prolonged and dangerous struggle, he was lassoed a second time, and then followed another most exciting incident. While the new rope was being tied to a tree about sixty yards distant from that to which the first had been made fast, the bull being at this time about midway between the two, the bull, in the twinkling of an eye, charged the man who was making the rope fast, broke the first rope, and tossed his victim, a Mohammedan butcher, wearing a red *pagri* (head-cloth), about twenty feet through the air. He next charged a cart which he failed to overturn, and then made a savage attack on one of the cartman's bullocks, goring it from under the yoke, and pursuing it for some distance. By this time we had all made our escape—up trees or by the ladders. After an hour's hard work, he was at last brought to his knees and securely tied. The remaining two were also accounted for before the day was done. One of these afforded considerable sport, as he was caught by the hind leg while running over the noose, which had been meant for his head, but which had fallen short of the mark. He bellowed wildly, stretched himself like a trapped rabbit, and pawed the earth in his wrath.

All four were at last tied to trees, but there was still a formidable task before us, for the bulls had to be brought to the nearest Government Farm—some forty miles distant, where they were to be tamed, and, if possible, trained. The method of transfer was to tie each bull between a pair of village buffaloes. The bull, which at the time of his capture, had injured two of our men so badly, displayed his savage temper once more, by making an attack on one of the buffaloes, which he gored so badly that it succumbed to its injuries. This same bull has since been successfully tamed and now labours under the yoke and treads out the corn on the Government Farm. He is still somewhat surly in temper, more alert and quicker in his movements than his fellows which have never known a life of freedom in the jungle, but he is, nevertheless, a useful draught animal.

Over thirty animals were captured last hot weather in a *kheddah* of this kind, but we do not recommend it as the most suitable. The area of about three acres inside the *kheddah* was much too large and great difficulty was experienced in approaching the enclosed cattle sufficiently near to lasso them. Moreover, when once enclosed, they become dangerous, and a man can only approach them in safety by taking shelter in a heavy cart as already described. A more successful method tried was to construct a very small *kheddah* forty feet square, of strong, wooden posts three feet apart and seven feet high, with cross pieces one foot apart. To give this fence additional strength a stay is put in behind each post. The cattle are allured inside as described in the case of the previous method, and the gate is then quietly closed by the watchman in charge. They are then lassoed one by one by men who have taken up their position in trees overhead. Fifteen were captured in this way recently without much danger or trouble. The text-figure shows how this was accomplished. This method is easily the cheaper and more expeditious and will be adopted in future as the standard method of capturing other wild herds.—[*The Agricultural Journal of India.*]

STRANGE WAYS OF USING WOOD-PULP.

PAPER LAMPS, CHIMNEYS, PAPER UMBRELLAS, BOOTS, BOATS, WHEELS—A FEW NEW USES FOR THE TREE.

There are probably no commodities in established use which have so greatly extended their sphere of utility as wood-pulp-fibres and paper, and within recent years the novel uses to which they have been, and are still being placed, have enormously increased in number. Mr. Gladstone is our authority for the statement that even 60 years ago the uses of paper were varied and numerous. In the speech to which we have just referred he stated that he had a list of 69 trades in which it was used. "For example," he said, "it is largely used by anatomical machinists to make artificial limbs; by telescope makers, by boot and shoe

Photo.-Mechl. Dept., Thomason College, Roorkee.

A METHOD OF CAPTURING WILD ANIMALS.

(Reproduced by kind permission of the Agricultural Adviser to the Govt. of India, Agricultural Research Institute, Pusa.)

makers, by cap manufacturers, for the foundation of caps and hats, forming all the peaks and many of the tops which look like leather; by china and porcelain manufacturers; by doll makers and by shipbuilders; and again making optical instruments, in pictures and looking-glasses, in portmanteaus, in Sheffield goods and tea-pots." "One manufacturer writes," Mr. Gladstone continued, "that he has made panels for doors from paper, and above all he looks forward to making carriages of paper when the duty shall have been taken off. Another manufacturer, who is asked into what combinations paper may be made to enter writes to me: 'Who can fix the limit to ingenious combinations when we see India-rubber being made into strong and durable combs and other articles of that sort?' Only this morning I was informed that paper pipes are actually made prepared with bitumen and capable of standing a pressure of 300 pounds of water to the inch." This was nearly two generations ago, and during the intervening years it has become increasingly recognized that not only may paper be found useful for other than printing, writing and packing purposes, but that wood-pulp is capable of being advantageously used in the manufacture of other goods than paper and cardboard. Pulp and paper, says the *British Paper Trade Journal*, have furnished a rich field for exploitation, and in altogether new spheres of usefulness have arrived at a stage which may be said to guarantee their permanent serviceability. Nowadays, the public are familiar with artificial silk, coarse cloth, and fabrics closely resembling mercerized cotton produced from wood-pulp fibres, and it is stating nothing new to say that ties and waist-coats are being made from pulp and paper. As a matter of fact, both pulp and paper can now be formed into solid substances capable of competing with wood or iron in point of durability and elasticity, and for some years past, treated by special methods, they have been converted into such articles as paper bottles, figures, ornaments, furniture, etc. Waterproof coverings for walls and ceilings, parchment slates, flanges and manhole rings, paper wheels, roofing and boats, paper barrels, gas pipes, boxes and horse-shoes are also no longer novelties. Probaly one of the most valuable by-products of

the manufacture of sulphite pulp is that of spirit from the waste, and particularly in Sweden, the distillation of alcohol from cellulose bids fair to become an industry of considerable importance. Then it is but a few years since the Chairman of the Tanning Section of the Toronto Board of Trade declared that paper inventions had gradually entered into competition with leather, and that hides had advanced in price to such a degree that the output had dropped 50 per cent. in Canada, a condition of affairs which had compelled the use of such substitutes as fabrics and paper.

BUILDING BOARD.

Paper as an article for building purposes is well known in Scandinavia and Japan. In the latter country not long ago a country house was entirely constructed of paper, and in Scandinavia a great quantity of wood pasteboard is used as the lining for wall papers. While in the United States a heavy paper board for use in building operations is also made from waste sugar, sugar-cane and corn stalks. In a small mill at Koyasa, Kanagawa (Japan), waterproof paper is now manufactured for shirt-making.

Paper string and twine has within recent years come to be recognized as a valuable substitute for the ordinary variety. Paper string is now being made of such stoutness that it is suitable for tying up parcels of quite a fair size, and its manufacture is now being carried out in this country. Twine has been produced from paper in Germany for some years ; the cord is spun from strips of brown or white creped thin cellulose paper and the few mills making it are said to be unable to meet the demand.

Paper Umbrellas.

Making artificial flowers from paper is not a new idea but it is probably not so well known that they are now being made of paper rendered non-inflammable by the moderate use of asbestine. It may also be recalled that a demonstration given in Toronto a short time ago, samples of sections of chandeliers, lamp brackets, etc., made from sulphite pulp, which had been subjected to a very high pressure and then blown into metal moulds were shown, while

paper lamp wicks are said to be now replacing cotton wicks throughout Austria-Hungary. The Japanese sunshade is, of course, quite a familiar object, but the collapsible and storm-proof paper umbrella, devised for use in emergencies by an ingenious American, has not yet obtained wide favour. Tests, however, are said to have shown that with ordinary care the cover will last for months in heavy rain and strong winds.

Paper Lamp Chimney.

Twisted or hardened paper is also being extensively employed at Sheboygan, U. S. A., in the manufacture of paper furniture, and bags and trunks of compressed paper are perhaps somewhat better known than the paper jackets for sausages, which have been introduced on the other side of the Atlantic. Vulcanized fibre, which is simply paper treated with zinc chloride, is also being extensively used in the manufacture of tool handles, bobbins, tubes, etc., and paper binder twine, paper window shades, paper matting and paper floor coverings, the latter generally made with an admixture of cotton, are now widely used. Paper insulators are, of course, in comparatively common use, but it must be admitted that a paper chimney, of which we have heard, is something of a novelty. Paper cart-wheels and paper boats are, however, no longer curiosities, though it is stated that the paper boat is, indeed, a very substantial and serviceable craft.

The great war has also developed new uses for paper and pulp. It is now well known that Germany is using chemical pulp in place of cotton as a basis for the production of high explosives and a German military surgeon goes as far as to say that not only cellulose wadding, but mechanical wood-pulp, wood flour, wood wool and wood felt have done good service as substitutes for cotton in making dressings, while another authority states that for wound secretions, filter and blotting paper serves the purpose admirably. Cellulose wadding is used in dozens of forms as a substitute for cotton, and its employment is stated to be even more advantageous when loosely cotton woven cotton wicks are substituted for closely woven wicks, particularly in spirit and petroleum lamps. There

have also been stories of paper boots and paper socks worn by soldiers of the European battlefields and it is reported that paper beds, with paper sheets and pillow cases, are now being used in Germany by the poor, the mattresses being made of strong sheets of paper pasted together and filled with dry leaves of beech and oak trees. The paper used is toughened by a special process which prevents easy tearing. In this connection, it may be mentioned that recently in Copenhagen a new German textile, in which paper is spun with about 20 per cent. of cotton, was exhibited. From this, paper under-clothings, sheets, jerseys, bandages and horse blankets were made but it is admitted that the cost of production is too high to allow of its competing with cotton and cloth in normal times. Probably the largest use of spun paper in the United States lies in the manufacture of fibre rugs, in the production of which no fewer then twenty-five factories are engaged, one of them turning out something like twenty-five tons of rugs daily. Most of these rugs are made entirely of paper but in some instances an admixture of cotton or wool is used. The possibilities for sulphite pulp in the manufacture of toys was a topic upon which Sir George Foster recently dilated at a manufacturers' convention in Toronto, and at a school near Southport, waste paper, after being pounded and kneaded, is now being used in place of clay for modelling purposes.

Altogether there seems to be no limit to the potential uses of either pulp or paper, and there is no doubt that in the near future considerable developments in this direction will have to be recorded.—[*Canadian Forestry Journal.*]

DOMESTIC OCCURRENCES.

BIRTH.

MARTIN—At Betul, C. P., on the 29th November 1917, to Dorothy, the wife of L. K. Martin, C. P. Forests, a daughter.

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A STUDY OF LABOUR CONDITIONS IN A U. P. PLAINS DIVISION.

(Contributed.)

Practically all the work of produce extraction in the division to which I refer is done by purchasers' agency, and the department has little concern with the labour engaged thereon; so it is not proposed to deal with this branch of activity. The primary object of this article is to discuss the methods and agencies by which departmental works, such as the repair of roads, the cutting and burning of fire-lines, and silvicultural operations are carried out.

The tract in which the forests are situated is thinly populated and backward. The labour locally available is scanty, of poor physique, and low efficiency; it is occupied primarily in agriculture and consequently difficult to obtain at all at seed or harvest time. It is becoming increasingly necessary to import labour by rail from a distance, and it will doubtless have to be brought from further and further afield as work develops.

The chief stand-by of the division at present is the seasonal labour supply from the Nepal hills. These *paharis* are honest and intelligent workers, with an efficiency at least 50 per cent. higher than that of the cooly of the plains, and are not exacting in the matter of advances—a subject which will be dealt with presently. They are particularly expert at burning operations and at silvicultural works such as markings and cleanings, but look on spade work with disfavour; hence *desi* or plains labour has to be depended upon for the extensive road work of the division. The *pahari* labour supply is unfortunately available only from the middle of December to the middle or end of March, when the men return to their homes in the hills; and the whole of the work, for the execution of which the department is dependent on them, has to be concentrated in this brief period. The *paharis* are extensively employed by contractors for the cutting up of fuel, but the supply of this class of labour in normal years is ample, and the combined requirements of the department and of contractors have hitherto been met without difficulty or competition.

The situation as regards *desi* labour (in this term I include not only local labour but that imported from the surrounding plains tracts) is complicated by what may be termed the 'advance system.' Generally speaking, no labourer will stir from his home unless he receives a cash advance equivalent to the value of the work that he is immediately required to do. This money he expends on the spot in making provision for his own food and for the maintenance of his dependents during his absence at work. When he has finished the particular job for which the advance was made, it is sometimes possible to keep him at work by advancing a further sum; this is particularly the case when the labour is brought from a distance. Very often, however, those whose homes are near insist on returning to them and have to be fetched again after a brief interval with payment, of course, of a new advance. The hand-to-mouth existence of the class from which the labour is drawn seems chiefly responsible for the practice, but the fear of being defrauded, deeply ingrained by experience of *begar* or forced labour in the less civilised past, is probably an important contributory motive.

There is no hope of getting rid of the institution for at least decades to come, nor until the standard of living is materially raised. So the best has to be made of it, and an elaborate system of accounts and safeguards has been evolved to deal with it. In practice, attempts on the part of labourers, who have received advances, to evade their liability to repay them by equivalent work are uncommon, but this result is obtained only by close supervision from the moment that the advance is made to the moment when it is recovered by work done.

The idea will immediately occur that all the trouble, which this system involves, might be avoided by employing contractors to execute the work. This is true in the case of work which admits of accurate previous estimate and subsequent measurement, which condition many classes of forest work do not fulfil. In such cases, the trouble could be avoided—at a price. Under this system, the contractor (the term is used to denote a man who will undertake work without being paid for it in advance) must have capital. To illustrate this, it may be mentioned that contractors engaged in timber extraction often have to distribute thousands of rupees in advances before a stroke of work is done. He must, moreover, have the faculty for organizing the recruitment of labour and for getting good work out of his men. He incurs some measure of financial risk in making advances and cannot rely on the authority of Government to back him in recovering them. Naturally he expects to be rewarded by a handsome profit. He is more or less a middleman in the labour market, and the middleman's profit, in this country particularly, is not of modest proportions. While it may be necessary, as an alternative to large increases of staff, to resort to this agency to a greater extent in the future, there are indications that departmental works can be carried out at present with greater economy and efficiency by more direct dealings between the department and labour. Not the least symptom of this is the absence of any demand on the part of contractors to undertake work at current rates ; work has in fact often, within my experience, been refused as unremunerative.

An efficient agency for carrying out contract works consists in petty contractors or 'mates' of cooly origin, who have not sufficient capital to finance their work without advances, but who are sufficiently trustworthy to be relied upon to work off advances made to them without constant supervision. The gangs which these men control are usually composed of their relations or caste-brothers, and the standard of industry is naturally higher than in the case of labour working for an outsider. Unfortunately, mates answering to the above description are very few in number—there may possibly be eight or nine of them for the whole Division. The gangs are mostly of the *lonia* caste, the traditional occupation of which is earthwork, though cultivation has now superseded this occupation as their primary means of subsistence; and they are employed entirely on road work. This system demands that range officers should be in close touch with, and possess the confidence of, the mates—a condition which frequent transfers render difficult of fulfilment, and which, moreover, tends to restrict the application of the system to labour resident in the immediate neighbourhood of the forest.

Of the two agencies above described, the first is undesirable on the ground of its costliness, and the second is limited by the scarcity of trustworthy mates. Both are inapplicable to work which does not lend itself to payment at piece-work rates, as to expect labour to work for a daily wage without supervision would impose too severe a strain on human nature; and if there must be supervision there is no point in employing a contractor.

But work has got to be done and labour has to be found to do it, so where these two agencies fail, resort must be made to the forest subordinate as a recruiter and supervisor of labour. This is actually the case with a very large proportion of the work which is done by *desi* labour. Works requiring knowledge of silviculture are supervised by rangers, deputy rangers and foresters, attached to the ranges; the supply of these officers is not always adequate to, and never in excess of, requirements. Straight-forward works needing no great technical knowledge, such as the repair of roads and the cutting of fire-lines, are in the hands of

forest guards. If the labour can be induced to come to the range officer to receive advances before going to work this is done, and the advances are paid out to the gang in the presence of the subordinate who is to supervise it; if not, as is more usually the case when the men reside at some distance from the forest, the advance money is entrusted to the subordinate for distribution. In both cases, the subordinate is made responsible for the recovery of the advance by the execution of the work for which it is made; and the measure of his responsibility is recorded by showing the advance as outstanding against him in the range ledger. The position of Government is safeguarded by ruling that advances may not be made to subordinates in excess of the security they have deposited. The whole procedure is perfectly just and reasonable. The range officer cannot assume sole responsibility for work to be done by men whom he probably does not know, whom he cannot constantly supervise himself, and who, unless constantly supervised, will do just as little work as they feel inclined to—which, in the case of the average *desi* labourer, is remarkably little. He *must* devolve responsibility on the supervising subordinate. The latter is entrusted with so much potential energy, in the form of labour, to do a certain job; just as a chauffeur might be entrusted with so much potential energy in the form of petrol to carry him a certain distance. The method is applied both to piece-work, if the labour can be induced to accept payment on that basis, and to work done on daily labour; in the latter case, strict rules have to be enforced as regards the upkeep of muster-rolls, which the subordinate in charge would otherwise be in a position to falsify.

The only other danger of the system when the distribution of advances is entrusted to subordinates is that the latter may misappropriate some portion of the money and get the work done by forced labour; but I am personally of the opinion that this danger is much exaggerated. A large proportion—certainly more than half—of the labour recruited in this manner consists of people over whom the average subordinate has no means of acquiring the necessary influence. The reputation of a subordinate who resorted

to such practices would spread rapidly; he would be avoided by labour which would otherwise be willing to come to work, and would fall into bad odour with his superiors as a man who failed to get his work done. The villager of to-day is not altogether inarticulate, and when at work in the forest he has constant opportunities of voicing his grievances. I would not, for a moment, suggest that the forest subordinate of the lower grades is a wholly trustworthy being with embryonic white wings, nor even that a certain amount of profit is not made by him under the system; but I believe that the game is too dangerous to be widely played and that the profits are trivial as compared to those which a contractor undertaking the same work would expect to make. *All the evidence points to this conclusion.*

Possible safeguards are: firstly, to make the subordinate produce receipts for the money advanced—I do not place much faith in this as such receipts are too easily fabricated; secondly, that the final payment (not a cash payment but practically a mutual acknowledgment of the conclusion of the transaction) should take place before the range officer who will satisfy himself by questioning the labour as to whether the original advance was paid in full.

The system has been objected to on the ground that it involves 'the employment of forest guards as contractors.' This phrase may be read in two ways, according as one accents 'forest guards' or 'contractors'; but it would appear that the objection relates really to the inclusion of such a low paid and *primâ facie* untrustworthy agency as that of forest guards; for the employment of higher grades of subordinate in precisely the same manner *passes without criticism. I do not regard the 'contractor' analogy* as a reasonable one, implying as it does, that subordinates are given money to do work, and that so long as the work is done, no interest is taken in the means employed to do it, nor in the possibility of profit being made. The actual system of getting work done through subordinates is not, to my mind, in the least objectionable provided the work is done cheaply, efficiently, and without oppression; and the burden of proof that the contrary has been the case lies upon its critics.

As to whether the objection to the employment of forest guards as a labour agency for the execution of works is justified or not is a matter of opinion. If it is, some alternative agency must be found to replace them. The limitations of the systems, which do not rely on subordinate agency, have been fully dealt with, and for classes of work to which they cannot be adapted it would be necessary either to constitute a higher grade of subordinate, *e.g.*, the forester class, as the executive unit, or to raise the pay and status of the forest guard. As there are limits to the number of labourers one subordinate can supervise, be he ranger, forester, or forest guard, the former procedure would necessitate a large increase in the grade selected in order that its capacity for getting work done should be equivalent to that of the present staff of forest guards. The total staff of foresters, for example, would have to be made at least numerically equal to the existing establishment of forest guards.

I consider personally that the degree of efficiency attained in work done through forest guards is remarkable, considering the class of men obtainable at the present rate of pay for this grade, and that cause has not been shown for their arbitrary exclusion from the executive organization. There is, perhaps, a case for improvement of the pay and status of forest guards in recognition of the reponsibilities they have to undertake; but to relegate the present personnel of the grade to the position of peons or fire-watchers, denying to those members of it who have shown themselves capable of good executive work admission to the new executive grade, would be ill-advised and unjust. Doubtless, plenty of men can be obtained as recruits to the grade of forester and upwards who possess higher literary qualifications, but these by no means necessarily connote a faculty for handling labour.

This article has drawn out to a length never intended but I should like before concluding to touch on a recent departure in labour methods, *viz.*, the employment of permanent gangs receiving no advances but paid a monthly or weekly wage. This system has been introduced in certain divisions, mainly, I understand, in connection with silvicultural works demanding some

degree of technique on the part of the individual labourers. It is less necessary in the division to which this article relates, owing to the fact that many *pahari* gangs are already expert in the technique of silvicultural works, which they undertake regularly year by year. But experiments have been made of late with permanent or semi-permanent gangs for the current repairs of roads under traffic, and for road work which is not of a sufficiently uniform character to be paid for on the basis of measurement. The extension of the system is limited firstly by the fact that piece-work is generally more economical than work done by labourers on a daily wage, and secondly, by the shortage of thoroughly reliable subordinates for the supervision of the gangs. Even silvicultural works can be, to some extent, standardized and the expenditure per unit of area compared with previous figures. But the multitude of diverse petty operations necessary to bring an irregularly surfaced earth road into perfect repair defy standardization or check, and it is necessary to place a greater degree of reliance on the intelligence and integrity of the subordinate in charge than is usually justified with the men at present available.

RATE OF GROWTH OF BAMBOOS.

BY B. B. OSMASTON, I.F.S.

Every Forest Officer knows that young bamboo culms grow with extreme rapidity and reach their full size both in height and external diameter in a few weeks.

Being anxious to test experimentally the actual rate of growth of such culms and also to ascertain, if possible, what factors influenced this rate of growth, I carried out careful measurements of a number of young culms of the year belonging to a large clump of *Dendrocalamus giganteus* growing in my office compound at Dehra Dun.

The measurements were made with a Surveyor's Measuring Staff from bench marks fixed at ground-level (a separate one for each culm), the level of the top of the bamboo being referred to

the measuring staff by means of a wooden rod with a mason's level mounted on it Measurements of 17 new culms were commenced on the 19th August, on which date the tallest was under $4\frac{1}{2}$ feet in height.

The measurements were read regularly twice a day, *viz*., at 6 A.M. and 6 P.M. so as to record the night's growth as well as that of the day.

In a few instances, measurements were taken at shorter intervals in order to ascertain the effect, if any, on rate of growth produced by (1) rainfall and a saturated atmosphere or (2) sunshine and a reduced relative humidity.

The first point that I should like to refer to is the period of growth of the new culms. Both Brandis (*Indian Trees*, page 663), and Gamble (Bambuseae, Introduction, page v), state that new culms usually develop in the early part of the rainy season. This I did not find to be the case with any of the numerous species of bamboo growing in Forest Park and the College Grounds in Dehra.

The young culms appeared early in August and growth in height was completed by the end of November.

The growth was at first very slow, gradually quickening for four to six weeks until the bamboo was some 12 feet or so in height when a maximum rate of growth was attained, which was maintained fairly uniformly for several weeks, after which the rate gradually decreased till the end of November when growth ceased.

In the case of *Dendrocalamus giganteus*, the species of which I took measurements, the heights in feet of the seven tallest new culms on September 1st, were respectively :—

12·82, 7·13, 3·28, 3·26, 2·51, 2·47 and 1·09.

It, therefore, appears that new bamboo culms commence to develop towards the middle of the rainy season, and that they do not complete their height-growth until a couple of months or so after the rains normally cease.

This late development of the new culms is hard to explain, especially when taken in conjunction with the fact that the rains

usually commence in Dehra towards the end of June and finish by the end of September. This year they began earlier than usual and finished late, the rainfall registered for the months April to November being as follows :—

April, 1·52″	May, 1·79″	June, 8·39″
July, 39·77″	August, 27·72″	September, 26·36″
	October, 6·92″	November, 0·0″

The second point which came out in the measurements was that the growth that took place in the night was usually nearly double that in the day, as may be seen by a reference to the measurements of a single culm, taken morning and evening for a fortnight.

In these 14 days the aggregate of the height increments by day was 3·70 feet against 5·95 feet by night.

This striking difference has, however, apparently nothing to do with light nor is it directly connected with temperature.

The maximum rate of growth is attained when the relative humidity is greatest ; or, in other words, when the atmosphere is saturated, and this is the condition at night both during, and shortly after, the rains.

Directly the sun rises, the temperature rises too, and unless it is actually raining, the relative humidity falls. This means that evaporation commences from the surface of the growing portion of the culm, thereby reducing turgescence, a condition essential for growth.

That growth can take place as rapidly by day as by night, given suitable conditions of saturation, was proved by taking measurements before, and after, periods of steady drizzle and rain, *vide* day measurements recorded at 4-hour intervals on August 29th and 30th and on September 1st.

The most rapid growth recorded in a single day was on September 1st when the culm grew nearly 13 inches in the 24 hours. This corresponds to a movement nearly three times as fast as the tip of the hour-hand of a wristlet watch.

This rate of growth was maintained approximately for the next nine days at least, during which period the bamboo grew

9·18 feet. It had then attained a height of 23 feet and measurements, becoming difficult, were discontinued.

This culm reached its full height (71 feet) about November 15th, so that it took altogether 3½ months to develop.

Other culms took a little longer but all had practically ceased to grow in height by the end of November.

A chart (Plate 4) is appended which has been drawn up for me by Major Cowie of the Trigonometrical Survey, giving the daily rainfall and temperature figures for the hot weather and rains of 1917. These will be of interest when considered in connection with the period of growth of the bamboos discussed above.

HEIGHT MEASUREMENTS OF A YOUNG CULM OF *Dendrocalamus giganteus.*

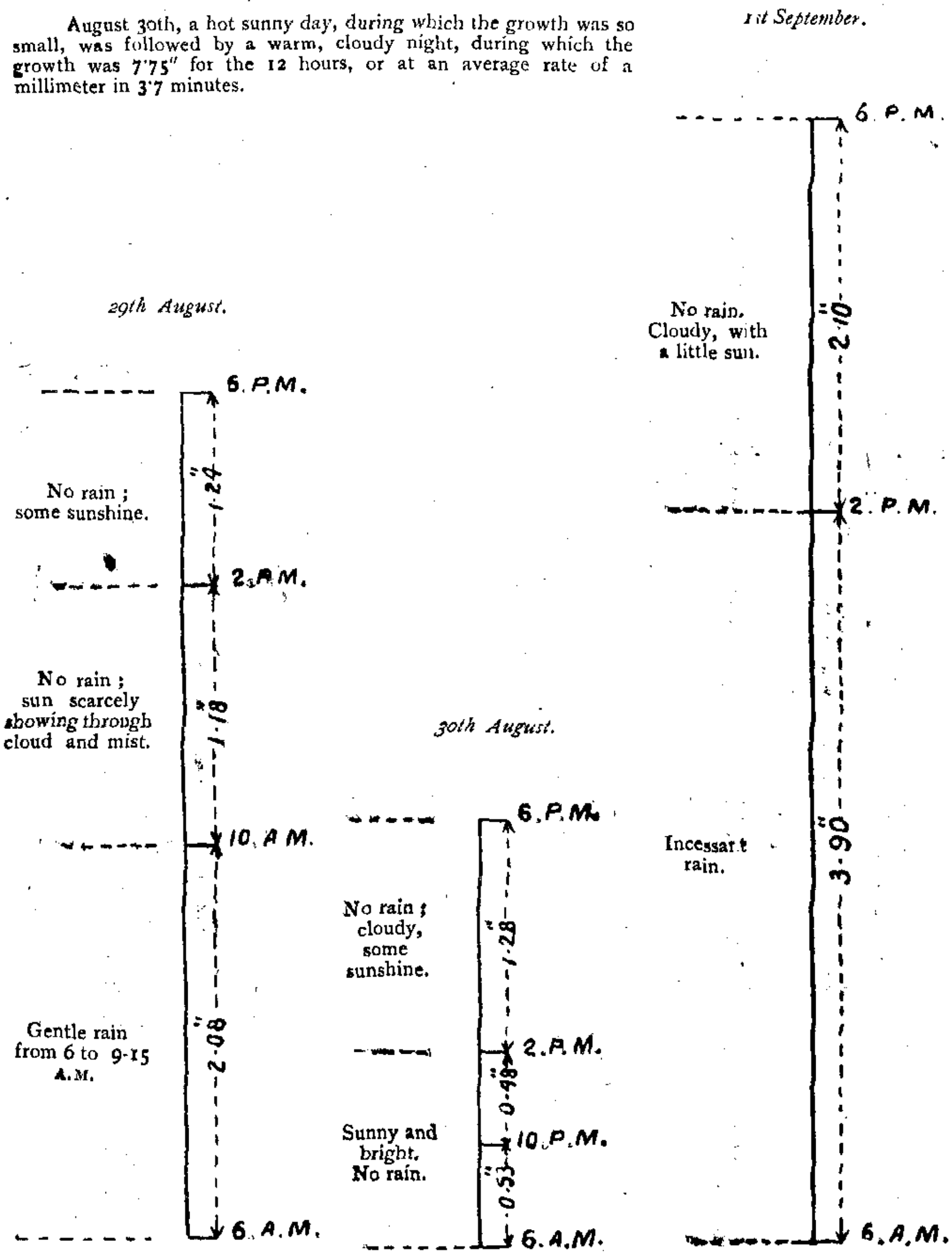
Date.		Hour.	Height in feet.	Growth. Day.	Growth. Night.	Total growth in 24 hours in inches.
August	19th ...	6 A.M.	4·15			
		6 P.M.	4·26	·11		
,,	20th ...	6 A.M.	4·46		·20	4·8
		6 P.M.	4·66	·20		
,,	21st ...	6 A.M.	4·86		·20	4·1
		6 P.M.	5·00	·14		
,,	22nd ...	6 A.M.	5·27		·27	6·2
		6 P.M.	5·52	·25		
,,	23rd ...	6 A.M.	5·82		·30	6·7
		6 P.M.	6·08	·26		
,,	24th ...	6 A.M.	6·66		·58	9·4
		6 P.M.	6·86	·20		
,,	25th ...	6 A.M.	7·11		·25	5·8
		6 P.M.	7·34	·23		
,,	26th ...	6 A.M.	7·77		·43	8·6
		6 P.M.	8·06	·29		
,,	27th ...	6 A.M.	8·54		·48	9·8
		6 P.M.	8·88	·34		
,,	28th ...	6 A.M.	9·38		·50	9·4
		6 P.M.	9·66	·28		

Date.	Hour.	Height in feet.	Growth.		Total growth in 24 hours in inches.
			Day.	Night.	
August 29th ...	6 A.M. 6 P.M.	10·23 10·58	·35	·57	11·0
" 30th ...	6 A.M. 6 P.M.	11·05 11·22	·17	·47	7·7
31st ...	6 A.M. 6 P.M.	11·86 12·24	·38	·64	12·2
September 1st ...	6 A.M. 6 P.M.	12·82 13·32	·50	·58	13·0
" 2nd ...	6 A.M.	13·82	...	·50	

Measured again on the morning of September 11th, the height was 23 feet, giving an increase of 9·18 feet in nine days.]

Actual growth of same culm on three days in August—September.

August 30th, a hot sunny day, during which the growth was so small, was followed by a warm, cloudy night, during which the growth was 7·75″ for the 12 hours, or at an average rate of a millimeter in 3·7 minutes.



FIELD INVESTIGATION OF 'SPIKE' DISEASE IN SANDAL ON THE KOLLIMALAI HILLS.

BY M. RAMA RAO, SPECIAL FOREST OFFICER IN MYSORE.

The sandal occurs in patches on the Kollimalais. The several species of plants with which it is associated are given in the list appended. The altitudinal limits of its occurrence are between 1,500′ and 4,200′.

In the middle of 1912, 'Spike' disease was reported to be absent on these hills, as also lantana. But in April 1914, the disease was reported to have attacked a young sandal sapling in the middle of Jambuthu Reserve on the western slopes. In October following, the District Forest Officer found there a number of young trees attacked and several plants dead, and thought that the disease had been there for some time previously. All the diseased living trees, which numbered 78, were uprooted in May 1915, when the local ranger reported that the disease had not spread to any other part of the hills. The girth measurements of the uprooted trees showed that the disease had attacked plants of ½″ to 12″ girth, there having been no bigger trees in that area.

In July 1915, I inspected this area and found the disease had spread a little higher up the brow of the plateau with an unaffected gap between it and the lower patch. On the eastern brow of the hills, about 8 miles east of the above spiked area, I discovered early in August 1915 a number of fairly large-sized trees, as well as saplings, spiked and many saplings standing dead. This area is near Sellipatti village. From their appearance I thought that the trees had been attacked much earlier than those in the Jambuthu area, because their leaves were much narrower and smaller, closer and more reddish-green than those of the diseased trees in the Jambuthu Reserve and there were besides a much larger number of dead trees also. In the latter area, the affected leaves were thinner, longer, deeper-green and somewhat more distant from each other and the branchlets themselves longer and more drooping. Whether these differences were due to differences in the external conditions of growth obtaining in the two localities as set forth

below, or to any peculiarities of the disease itself, is a question that remains to be investigated. On enquiry of the villagers of Sellipatti, living quite close to the affected trees, as to when they noticed it, they stated that it first appeared *three years previously.* Mr. P. M. Lushington, Conservator of Forests, inspected both the areas in January 1916 and thought that it was very probably so. Again, saplings in another patch close to the above and separated by a low ridge were found diseased. Between the two patches in both localities, there were sandal trees which bore no signs of the disease and were quite-healthy-looking. The numerous sandal patches between Jambuthu and Sellipatti were carefully gone over first by a trained ranger, a few months afterwards by myself, and five months later by Mr. P. M. Lushington and myself to see if spike had appeared in any of them, but we could find none

The external conditions of growth observed in the Jambuthu and Sellipatti spiked areas are as noted below :—

External conditions.	*Jambuthu.*	*Sellipatti.*
(*a*) Aspect ...	Western and therefore cool ...	Eastern and warm.
(*b*) Altitude ...	2,500' to 3,500'... ...	3,200' to 3,400'.
(*c*) Associates	Young and dense and semi-evergreen.	Open and scrubby evergreen.
(*d*) Soil ...	Reddish loam mixed with stones and rocky out-crops.	Dark loam with stones and boulders.
(*e*) Sandal ...	Mostly saplings and poles, but hardly any seedlings.	Fairly large trees and saplings and abundance of seedlings.
(*f*) Fires ...	Immune from fires being semi-evergreen.	Being over-grazed always, no fires had or could occur.
(*g*) Other diseased species.	*Zizyphus Œnoplia*, *Pterolobium indicum*, *Dodonæa viscosa* and *Jasminum* species occur but no root-attachments with sandal found.	Same species found but none close to affected trees, nor any root-attachments found.
(*h*) Proximity of other parasitic plants.	*Cansjera Rheedii* very commonly found but no root-attachments with sandal; *Viscum verruculosum* on a few sandal plants which were unspiked.	*Cansjera* very abundant but no root-attachments found. *Loranthus tomentosus* had attacked a healthy tree; *Viscum verruculosum* was found on a few unspiked sandal trees.

External conditions.	*Jambuthu.*	*Sellipatt.*
(*i*) Healthy sandal ...	In close proximity to spiked trees, many healthy sandal plants were found but without root connections with diseased trees, though their roots crossed each other.	Same was the case here too.

In both the 'Spike' affected localities of Jambuthu and Sellipatti, the root systems of a number of spiked trees and a few healthy ones in the neighbourbood were examined after carefully dissecting away the earth round them, and the results of examination are noted below :—

(1) The roots and rootlets of host plants in contact with, or close to, sandal roots were, generally speaking, healthy.

(2) The root-ends of spiked trees were in all cases dead.

(3) Haustoria were dead in almost all cases, but in a few live ones were found on roots of neighbouring host plants, but these might have been formed by other healthy sandal plants or by the *Cansjera*. Actual attachments could not be traced.

(4) In spiked trees, new rootlets were not produced as a general rule but, in a few cases, root fibrils had been formed, but they were blanched, weak and withered, the withering commencing at the tips. Such fibril-like rootlets had not formed any connection with neighbouring roots of other plants.

(5) Most of the root-ends of a sickly-looking sandal seedling which was not spiked were not dead and live root-attachments with other roots were found with live haustoria, even though the seedling had been badly attacked by *Viscum verruculosum.*

(6) The roots of unaffected sandal saplings and seedlings, in very close proximity to 'spiked' trees, were healthy-looking with the root-ends and haustorial connections alive and vigorous, although some of them crossed roots of spiked trees.

(7) In Sellipatti area the spiked branchlets were short and their ends dead, while similar branchlets in Jambuthu were much longer and drooping.

(8) No flowers were found on spiked branchlets in both localities. But in partially spiked trees, some branchlets bore normal leaves, flowers and even fruit, and to all outward appearance were unaffected.

(9) In Jambuthu, saplings which looked healthy in July were found spiked later and died in the following January, whereas in the Sellipatti area the same was the case with saplings, but older trees found spiked early in August were in the same condition externally in January and a few died only in April, thus seeming to indicate that older spiked trees take longer to be killed than younger trees.

10) A young sandal tree had one branch spiked, while the other, which was the larger of the two branches, had normal leaves and branchlets. The lateral root vertically below the spiked branch had its root-ends and haustoria dead, while the root below the other branch and diametrically opposite to the diseased root was much longer, had more tertiary roots and numerous rootlets and living haustoria with a number of attachments. In this case, where did the disease first attack the tree--whether in the crown or in the diseased root? If the disease is induced by a virus, and if the latter circulates in the sap, why were not the other branch and the root below attacked simultaneously? Again, does the crude sap sent up by a root or the elaborated sap sent down by a branch circulate only on that side of a tree on which the root or branch exists? These questions have to be elucidated by a Physiologist.

(11) Numerous young and healthy sandal rootlets were examined by me with a strong lens but, in no case, were root-hairs found, whereas on rootlets of host-plants, they were abundant.

(12) Among the spiked trees examined, no damage by insects or fungi was noticed either on the roots, stems, or branches. In one case, there were Rose-beetles and larvæ and, in another, Mycelia of a fungus close to the roots, but these latter bore no traces of attack by either.

(13) A few vigorous and quite healthy-looking sandal saplings, a little lower down the spiked areas in the Jambuthu Reserve, shed a number of young leaves of the new flush when the stems were shaken, which was not the case with other saplings. This was in January 1916 when the Conservator was present, and he thought this phenomenon remarkable. On examining the base of the petioles of the shed-leaves with a lens, I found that the fibro-vascular bundles were disorganized and weakened, while the basal ends of the petioles of similar leaves plucked off healthy twigs of other saplings did not exhibit this weakening of the fibres. One of the saplings was placed under observation and it was found quite normal and healthy in May 1916, and its root-ends were also healthy and had formed a number of attachments with other roots. This tree was some months later reported to have died, but whether its death was the result of any disease of which the leaf-shedding was an external symptom, or of the disturbance of its roots caused by digging round them for examination could not be determined.

(14) In almost all cases of withering of rootlets of spiked sandal, it was found that the withering commenced at the very tips and gradually extended upwards.

Our investigations on the Kollimalais tend to confirm most of the observations that had been previously made and recorded by Dr. Barber in his Report on Spike Disease submitted to the Board of Revenue, Madras, in 1902.

Dr Coleman's grafting experiments tend to show that the disease is communicable from tree to tree when in close organic contact, but they have not yet reached the stage of explaining the spread of the disease in nature from one area to another with an intervening unaffected space of many miles between. Thus, for instance, the nearest previously known spiked area from the Kollimalais was 80 miles away. How could the disease have skipped over such a long distance and have been communicated to the sandal trees in two distant patches on these hills? How could it have passed from Sellipatti to Jambuthu—eight miles apart—without affecting any sandal areas lying between them?

The disease was first discovered in Coorg in 1899. Mr. P. M. Lushington found a number of trees dead at Punachi in Coimbatore in 1898 and this was subsequently believed to be due to 'spike.' If this belief was correct, how could the disease have jumped over such an enormous distance, without appearing in the intervening vast area of sandal tracts? Even in Dr. Coleman's experimental plot at Bangalore, sandal plants, which have not been operated on in the grafting experiments, are quite healthy-looking and unaffected in spite of the close proximity of introduced 'spiked' plants for the last *three* years.

These facts lead one to be sceptical as to the contagious or infectious nature of the disease, and to be inclined to believe that after all it may be endemic and spontaneous. Meanwhile, we must patiently wait and see what further developments Dr. Coleman's experiments at Bangalore and Mr. Hearsey's experiments in connection with his 'Insect' theory will lead to.

APPENDIX A.

LIST OF HOST-PLANTS OF SANDAL TREES IN THE 'SPIKED' AREAS ON THE KOLLIMALAIS.

Serial No.	Botanical Name.	Vernacular Name.	REMARKS.
1	*Cansjera Rheedii* ...	Vandathuluru ...	Sparingly attacked by a root parasite—probably sandal.
2	*Anogeissus latifolia* ...	Namai	Largely attacked by root parasite—sandal or *Cansjera*.
3	*Acacia pennata* ...	Seengai ...	Largely attacked by sandal.
4	*Vitis pedata* ...	...	
5	*Cipadessa fruticosa* ...	Péna sedi.	
6	*Fluggea leucopyrus* ...	Vellai-púla.	
7	*Albizzia odoratissima* ...	Selai-usilai.	
8	*Erycibe paniculata* ...	Onán kodi.	
9	*Phyllanthus Emblica* ...	Nelli.	
10	*Mallotus philippinensis*...	Gundansólai ...	Sparingly attacked by sandal roots.
11	,, *Lawii* ...	Sólai-karupichchi.	
12	*Murraya exotica* ...	Vellari.	
13	*Clausena indica* ...	Ana	Largely preyed upon by sandal roots.
14	*Schleichera trijuga* ..	Púvandi.	
15	*Dolichos* sp.?	Kattu-thamattai.	
16	*Pterolobium indicum* ...	...	
17	*Cryptolepis Buchanani*...	Pālkodi ...	Sparingly attacked by sandal.
18	*Webera corymbosa* ...	Veppura ..	Attacked by sandal pretty extensively.
19	*Olea dioica*	Perumpungu ...	Extensively attacked by sandal.
20	*Litsaea zeylanica* ...	Thagari.	
21	*Zizyphus Œnoplia* ...	Súri	Sparingly attacked, as there were only a few scars of haustoria.
22	*Smilax scandens* ...	Kodali-kodi.	
23	*Cudrania* sp. ...	Egadi.	
24	*Jasminum sessiliflorum ?*	Kodi-malli.	
25	*Elæagnus umbellata* ...	Sirum-kulleri.	
26	*Flacourtia Cataphracta*...	...	
27	*Memecylon edule*	Varicha.	

Serial No.	Botanical Name.	Vernacular Name.	REMARKS.
28	*Eugenia Jambolana* ...	Navvéy.	
29	*Morinda umbellata* ...	Sandikodi ...	Pretty extensively attacked by sandal roots.
30	*Clematis Gouriana* ...	Ponrakodi.	
31	*Ardisia humilis* ..	Kollurumai.	
32	*Celtis* sp.	Peenjani.	
33	*Ehretia buxifolia* ...	Korakku-vettilai.	
34	*Ligustrum neilgherrense*	Mani-pungan ...	Fairly largely attacked by sandal roots.
35	*Randia dumetorum* ...	Markällan.	
36	*Zizyphus rugosus* ...	...	
37	*Ficus asperrima* ...	Péperukkai.	
38	*Asparagus racemosus* ...	Thannir-muttan.	
39	A lauracious shrub with	wavy leaves.	
40	*Gymnosporia montana* ...	Kattanji ...	Largely attacked by sandal.
41	*Premna tomentosa* ...	Narumpinji.	
42	*Ochna* sp.	...	
43	*Tiliacora racemosa* ...	Kattu-kodi ...	Largely attacked, probably by sandal roots.
44	*Embelia viridiflora* ...	Kákatián.	
45	*Coculus macrophyllus* ...	...	
46	*Dioscorea pentaphylla* ...	Mullánkodi.	
47	*Memecylon Heyneanum*	Káyila.	
48	*Canthium didymum* ...	Alumba.	
49	*Strobilanthes* sp. ...	Kurunju ...	Extensively attacked by sandal.
50	......	Páku pattai.	
51	*Flacourtia sepiaria* ...	...	Fairly attacked by sandal.
52	*Atalantia monophylla* ...	Kurundu. Katelimicham.	Very largely attacked by sandal roots.
53	*Dodonæa viscosa* ...	Velál.	
54	*Breynia rhamnoides* ...	Sittuduvai.	
55	*Hiptage Madablota* ...	...	
56	*Pleurostylia Wightii* ...	Pávalichcha.	
57	*Zizyphus xylopyra* ...	...	

SPIKED SANDALWOOD.

BY C. M. HODGSON, I.F.S.

The following remarks, unless otherwise stated, apply only to the North Coimbatore Forest Division. I write to record my opinion that spike is not caused by fire, *Zizyphus*, lantana or any other feature of the environment but is an internal ailment due to some germ

My reasons for this conclusion are that :—(1) Side by side, and contiguous to each other, are large stretches of sandalwood of every description, *i.e.*, poor undershaded yellow-leafed trees, green-leafed well-shaded trees, trees almost growing in water under dense bamboos and *Eugenia*, etc., trees growing on dry hill tops, and subject to every imaginable variety of elevation and aspect, nurse trees, amount of shade exposure to fire, immunity from fire, moisture, etc. In the Satyamangalam Range one such sandalwood area is largely spiked, the other quite free of spike. The former occupies considerably over 150 square miles. The area of the latter is only about 60 square miles, but it is a long stretch of irregular width. In the former case, the elevation varies from 2,600 to 4,300 feet and trees are spiked at all these elevations. In the latter, the elevation varies from 1,700 to 3,800 feet.

(2) Spike keeps on attacking new patches in unburnable areas all more or less affected by spike, and it skips over other similar patches temporarily, only to attack the latter later on. (Instance :—Hosahatti.)

(3) Spike jumps ten miles of continuous sandalwood forest, then attacks a small unburnt area, refusing to spread into the neighbouring closed sandalwood compartment, which is frequently burnt, on the one hand, or to spread at all beyond some 50 acres of similar unburnt, heavily grazed forest. It is very deadly in the area affected, killing off most of the trees in one year, and many in a few months. (Instance :—Kodipuram.)

(4) Turning to individual trees we have every variety of attack. Sometimes the healthy well-shaded tree is attacked, sometimes its feeble neighbour. Sometimes chiefly the very young

trees, sometimes only the middle-sized and old. All this is regardless of whether the area be burnt occasionally or not. I may here remark that isolated patches of trees or single trees are found all round the heavily grazed unburnt areas, in areas burnt every 2—3 years, wherever the grass is not too heavy and the thorny *Scutia* prickly pear, or else *Webera*, *Canthium didymum*, etc., partially protect it against the flames. I have found spike in such cases but the reverse is the rule. There, as a rule, the trees are free from attack, in the presence of *Zizyphus*, while the true sandalwood area inside is badly affected.

(5) The presence or absence of lantana—we have it here in most places—seems to have no bearing on the incidence of spike.

(6) Going along rivers one finds spike particularly bad, especially in very moist places under *Bambusa*, for a stretch,—then absent, and so on. Sometimes it is much worse near a pond or stream, sometimes the reverse.

(7) There is no special spike season. It attacks all the year round.

(8) In all the above cases, one of the most curious and striking points is its persistent refusal to affect certain trees, either at all, or for the time being. Another is its general tendency to attack a limited area which often includes more than one kind of forest, and to eat away in that area, refusing for months or years to go beyond into varying types of forest it is freely attacking within its chosen limits. Its extraordinary jumps are only too well known, as are the varying degrees of rapidity with which it kills trees, taking anything from a couple of months to considerably over two years. After an area has been badly affected, the large number of very young spiked trees in unburnt areas of all sorts rules out the environment, not merely as a source of the evil, but as a factor of any moment. Spike spreads in all directions north, east, south and west.

I conclude that it must either be a physiological peculiarity of the tree, or else it must be caused by some germ.

From the history of its spread from somewhere near Coorg, as stated by Dr. Coleman, there can be little doubt that apart from

other means of infection it is spread by seed A mere sport of the sandalwood tree in general it cannot be owing to its peculiar spreading from one point. At first sight, it might be a sporting variety which originated near Coorg and gradually spread by seed and root-suckers. But can a sporting variety, when grafted contaminate the whole tree? The spiked tree has lost certain necessary faculties which the normal tree possesses. Then how can the grafting of the spiked scion deprive the stock of its normal faculties, unless the former possesses a virus?

If Dr Coleman's experiments be studied, it will be seen that, in some cases, a relatively insignificant proportion of the whole plant (stock plus scion) was scion. Could the excessive amount of starch in such a small scion gradually choke the cells of the whole tree in the presence of a rich foliage capable of active metabolism? It seems very unlikely. Moreover, it remains to be seen whether a healthy tree can, in any case, be stuffed to death in this way. Besides, an unhealthy sporting variety cannot kill out the healthy species in the struggle for existence, let alone the fact that there is ample room for both Now spike, as a rule, not only wipes out most of the trees sooner or later but, as has been also recorded in Mysore, dibbling operations in spiked areas (Hassanur) have been unsuccessful, whereas in a similar unspiked area (Thattakarai) they have been successful with no better management. This points, not merely to a virus in the plant, but a virus left behind in the ground.

Accordingly, I am compelled to resort to the virus theory. This theory gains much support, as explained by Dr. Coleman from the similar cases of Peach yellows, etc. We at least know that a virus will do this sort of thing.

I will now give some further observations I have made regarding spike :—

1. In the hot weather of 1916, the guards of the vernacular training school, carefully picked over a badly spiked plot in the small new Kodipuram spiked area of Talamalai Range, using pick-axes and mamooties. It had no effect.

2. I have marked individual vigorous looking spiked trees and had them watched in several beats. In only one case was it reported that the tree had recovered and I attach no importance to it as it was not a tree I had selected and the officer who selected it said he might have made a mistake.

3. When burning the Hassanur bungalow compound in March 1916, one sandalwood was killed and several badly scorched by fire. The latter have recovered. None became spiked. A few yards off outside the compound, several trees became spiked in 1917, in an area which has not been burnt for several years at all events.

4. I have observed hundreds of such scorched trees on fire-lines. In only one case, and that in a badly spiked locality, did any of the trees become spiked.

5. Severe hacking of the trees by the local people for obtaining chewing bark appears to have no tendency to produce spike. I have found hacked trees, and those rubbed by deer, spiked in already spiked areas but, on the whole, if any inference could be drawn it would be that hacking tended to prevent a tree from being spiked.

6. Injury to the roots by road-menders excavating holes beside the tree, and by jungle tribes digging for yams appears to have no effect.

7. In June 1916, at an acquired, formerly cultivated, area called Uchettikadu in the Manigar valley of Bargur Range I found a sandalwood area badly spiked, the surrounding forest being unspiked for a distance of over half a mile when the spiked Alanai village area was reached. I had previously studied the differences between true spike and a somewhat spike-like appearance on some rapidly sprouting trees in spiked areas—an appearance which vanishes on further development. The trees were badly spiked, some partially, some wholly. I specially ordered the Range Officer to have these trees removed. About December 1916 he reported that he could find no spike there. I made an exhaustive examination of this area in February 1917. It is a mixed satinwood, white Babul, *Canthium didymum*, *Terminalia Chebula*

Pterocarpus Marsupium area with an undergrowth of *Erythroxylon monogynum*, *Zizyphus*, *Webera*, *Dodonaea viscosa*, etc, unburnable through heavy grazing. There were no spiked trees and no dead trees. There was no sign of theft. It is a very unlikely spot for theft. I then went to certain isolated clumps of tree-growth where I had seen the spike, and examined every tree. Some were normal, but others just showed this, over the greater part of the tree, the leaves, though very healthy and of a somewhat darker green than that prevailing in the vicinity, were decidedly more coriaceous and wrinkled as well as shorter and wider than usual, there being a few branches lower down which bore absolutely normal leaves—apparently the original foliage of the portion which never became spiked.

8. In December 1916 I inspected a sandalwood area near Kakarai on the Yekkatur plateau of Satyamangalam Range, and found it badly spiked. Ranger Nicholas who accompanied me remarked that this portion of this badly spiked plateau had hitherto escaped. No dead trees were seen Early in October 1917 I inspected the same area. There were no spiked trees. There were four or five dead trees, others which appeared likely to die, others badly injured but recovering, others slightly affected in parts and recovering, and others which apparently had been completely spiked and had put on a complete new foliage without the loss of a branch, the young foliage in all cases contrasting with the normal foliage of the vicinity. As I personally know, no fire had occurred here for at least two years and the area is not one which is burnt as a rule, if ever. Such fires as could occur would be too light to do the damage, but barring the absence of charring, the sandalwood trees had the appearance of having been recently burnt It is one of those lower plateau flattish areas with satinwood, *Anogeissus*, *Terminalia Chebula* and many other species, the undergrowth being composed of *Dodonaea*, *Grewias* of various sorts, *Webera*, *Maba buxifolia*, etc. Some of the trees had lost all their branchlets and were putting out epicormic shoots along the stem and the base of the larger branches. Others had only lost the end branchlets or these and some of the main branches, and there was every degree

of injury. Here we have a case of spike followed by varying results in contrast to the Uchettikadu complete recovery.

9. I had previously been informed that spiked trees sometimes recovered in the Kollegal Division but could get no reliable details. I had also been assured by the Forest guard of Tingalur that very many spiked trees recovered there. He pointed out one particular tree which he said he had passed a hundred times, saying that when he first came there a year previously it was spiked. But one cannot be certain of such uncorroborated statement. In the Uchettikadu case I have no trained witness. In that of Kakerai Ranger Nicholas saw the spike in December 1916, but no reliable person was with me when I saw the after effects in 1917. Any one who is interested can go and see it now.

10. Judging from the very small number of dead trees, one finds in unspiked localities as compared with that in spiked, and from other observations, I am convinced that whether it kills all the trees it affects or not, spike sometimes attacks certain areas such as the Hoshatti Hassanur footpath area, kills a larger number of trees and completely disappears for a year or two, then afterwards re-appearing with virulence.

11. *Spike is extremely rare on* trees in old ploughed fields still under cultivation. It is seen in hedges between, and on unploughed patches. It is sometimes seen in newly broken fields and the ensuing cultivation does not save the tree. It is sometimes particularly bad in abandoned fields.

12. The people about Talaimalai say that they can kill off the sandal (which they detest) in their fields, by raising a crop of castor oil. If this be so, it is curious. The wild castor oil is a good nurse tree to sandal, which will grow under it in the absence of other growth, as I saw in the Gundamalai reserve of Anantapur District.

ARTIFICIAL PROPAGATION OF SANDAL.

BY L. P. MASCARENHAS, DISTRICT FOREST OFFICER, MYSORE.

Notwithstanding the great value of sandal (producing as it does an annual revenue, for the State, of 30 lacs), the future of this tree is endangered by the following factors :—

(1) The spike disease which has been responsible for incalculable damage during the last 15 years and the cause of which is still unknown.

(2) Goat-browsing. Goats are in every village and all sandal trees near the villages are mutilated and pollarded by these animals.

(3) The desire of the raiyat to keep his fields clear of sandal with an eye to immediate profit from his crops rather than to a bonus on sandal trees which he may get some years hence, and also with a view to avoiding the responsibility which would fall on him should sandal trees exist in his holding.

(4) Fire. The District forests which are the chief home of sandal are, as a rule, burnt annually by the villagers for the purpose of getting an early crop of green grass for their cattle.

(5) Damage by hares and deer.

With the object of placing the future propagation of sandal on a sound basis, therefore, the following suggestions are made :—

I. We now dibble sandal, as soon as the rains begin, in annual coppice coupes and compartments in District forests. The results, so far as one can see, are not promising, as the numerous enemies of sandal undo what is done by the department.

Hence I propose that in annual coupes sandal should be dibbled in five or six selected plots of one acre each, the plots being strongly fenced and the dibbling carried on for three years consecutively *in the same plot to ensure success,* and *with the idea* of forming future regeneration centres ; for instance, if the coppice

coupe is 100 acres, the Forest Officer in charge should select five or six plots, where no sandal exists, of one acre each, dibble the seeds in every bush possible, fence the area strongly, appoint a care-taker to watch the plots throughout the period, and carefully fire-protect them.

This work would be continued for three years. After four years the plots might be left to themselves.

II. The bonus scheme sanctioned in Government Order 7699—708, dated 25th March 1909, does not appear to have materially increased the number of sandal in cultivated areas.

In the Malnad and Semi-malnad tracts, every field is encircled by a live fence of lantana (*Lantana Camara*), Kare (*Canthium parviflorum*), or Tandrasi (*Gymnosporia montana*), lined by an avenue of Chujjalu (*Albizzia amara*), Iji (*Premna tomentosa*), Thapsi (*Holoptelea integrifolia*), Kagli (*Acacia Catechu*), Devadaru (*Erythroxylon monogynum*), Gorivi (*Ixora parviflora*), Bilwara (*Albizzia odoratissima*), Dindiga (*Anogeissus latifolia*), Channangi (*Lagerstrœmia parviflora*), etc., affording the most suitable conditions for the regeneration of sandal. I have seen in many places in Anvetti Hobli of the Sorab Taluk, hedgerows for miles together containing a profuse growth of sandal with a bright future before it. I, therefore, propose that large quantities of sandal seeds should be given over to raiyats, who should be asked to dibble them in their hedgerows. For every 100 seedlings raised by them, we should pay them at the rate of Rs. 10 per every 100 seedlings as follows :—Count the seedlings annually in November and enter the account in the Panhani Register of the Shanbog, then give them Rs. 3 in the first year, Rs. 3 in the second year, and Rs. 4 in the third year. For instance, a raiyat may show 400 seedlings in the first year, he must get Rs. 12 ; in the second year only 300 may survive and he gets only Rs. 9 ; the third year only 200 may survive and then he gets only Rs. 8 ; the Shanbog and the Patel may be each given 2 per cent. commission on the remuneration given to the villagers for maintaining regular accounts ; for every seedling the raiyat has wilfully damaged either by goat-browsing or by setting fire to the fence, the rules in force will come into play.

III. Large areas of scrub or pole forests, open and subject to heavy grazing and quite fit for artificial regeneration of sandal are being constituted into village forests. The members of the Forest Committee may be given sandal seeds to be dibbled over areas selected by the Forest Officer and the remuneration noted in II above may also be given to the headman of the committee to be utilized for the improvement of the village.

IV. Fine sandal is found growing in most of our date groves but fires, goat-browsing and lack of supervision account for the gradual disappearance of sandal from these areas. Such date groves as are suitable should be mapped and sandal dibbled in them systemetically by the agency of either the Excise or Forest Department.

V. Owners of private forests should be encouraged to grow sandal on the same principle of remuneration as above.

VI. All available waste lands should be taken up for fuel planting and sandal introduced in them.

The above suggestions of course entail considerable expenditure, but it is believed that this would be more than justified by the resulting revenue. I even go to the extent of suggesting the appointment of a Sandal Ranger for each district whose business would be to carry out the above scheme and see to the regeneration and preservation of sandal.

ATHLETICS AT THE BURMA FOREST SCHOOL, PYINMANA.

BY A. J. BUTTERWICK, INSTRUCTOR, BURMA FOREST SCHOOL.

Since the last article on this subject was published in the *Indian Forester* in June 1915, athletics at the Burma Forest School have progressed steadily, albeit slowly. We have been much hampered by the inevitable scarcity of funds due to the war, and our recreation ground is still badly in want of reclaiming and draining. However, a good deal of improvement has recently been done by the students themselves, and the grounds have become much more adapted for a good game of football and the better running of the sports.

A new well, built of reinforced concrete blocks made by the students themselves, has been constructed some distance from the football ground, and the former well, mentioned in the last article, has been finally filled in and levelled off. Football can now be played without any fear and hindrance. The field itself has been enlarged by the students, reclaiming the south-east corner of the ground with earth excavated from the hill which formerly jutted out on to the ground on the west. We have now a playing field 120 × 82 yards, which compares very well with the maximum football field of 130 × 100 yards laid down in the rules. A rough but efficient and commodious pavilion 40′ × 20′ has also been built on the afore-mentioned hill, from the material left over from the old mali's quarters in the nursery, and a magnificent view of the field of play can now be obtained in comfort.

Further, a few of the most necessary gymnastic apparatus have been erected on the vacant land on the east of the football field. These will form the nucleus of the gymnasium which we hope to have at the cessation of hostilities. It is to be regretted that the students, amongst whom there are some good gymnasts, have hitherto not taken a sufficiently keen interest in this interesting branch of sport.

Last, but not least, the Hon'ble Mr. J. E. Dubern, a prominent citizen of Rangoon, has very generously endowed a gold medal to be given annually to the best athlete amongst the senior students of the school. Mg. Kantaya, who passed out with flying colours last year, was the lucky recipient of the first Dubern medal.

Athletics, therefore, in the Burma Forest School have now definitely got into their stride, and the students are being made to realize, by every kind of advice and encouragement, that a good physical training is a *sine quâ non* in the education of an efficient Forest Officer.

To enable the Director and his staff to judge the annual winner of the J. E. Dubern gold medal, athletics have been divided into the following branches :—

1. Games. 2. Sports. 3. Marathon Race.

Marks have been judiciously allotted to these and the marks gained both as Juniors and Seniors will count for each student. A record book showing the results of Nos. 2 and 3 yearly has also been opened and will be carefully maintained. The British Amateur records have been obtained from England and entered above each event. These will act as efficient stimuli to the students and will show them the goals and the standards towards which they should concentrate all their efforts.

Games.—As mentioned in the previous article on this subject, the one and only game at present indulged in at the school is football. Owing to the unreasonable hostility, to which the school players were subjected in previous years by some of the local teams and their partisan spectators, the School authorities, whilst being perfectly agreeable to enter a team, decided this year not to take an active part in the thankless task of inaugurating a football league tournament in Pyinmana. There being no one else in the station willing to take up the discarded onus, there was no football league tournament held here this year. In one respect it was a pity, as we have at present an exceptionally well-balanced team and had every chance of winning the tournament. Therefore, on account of there being no league this year, and the Burma Railway authorities having cancelled the concession formerly allowed to football teams, the school eleven had very few matches in Pyinmana itself and only one match out of it. The former were mostly against scratch teams very sportingly brought together by the local Y. M. B. A., and the venue in all the matches was the school ground. The School was victorious in all these games by varying margins, the largest of which, as far as can now be recollected, being eight goals to *nil*. The one and only outside match took place on the 4th October 1917, when we met at Toungoo the Toungoo forest team, reinforced by the inclusion of some local players. In spite of the fact that our men had taken part, the evening before, in a strenuous Marathon race of 8½ miles, the school team managed to come off victorious by the satisfactory margin of four goals to one. Napoleon, one of our Karen students, was selected as football captain for the year, and as centre forward he did emulate, on the

football field, the brilliant exploits of his famous namesake on the battlefield. Marks are to be allotted to the players not only for skill in playing, but also for gentlemanly behaviour on the field, keenness in turning out regularly for practice, and playing up well to the end of the game, whether the School be winning or losing. To help the players, a statement of "Don'ts" has been written up and posted in a conspicuous position of the school. Burmans are naturally very keen on football, but the majority of them have not been sufficiently long enough under British tutelage to be good sportsmen. They do not know how to take a defeat or bear up with a toss even though it be illicit. In this School, it is our earnest ambition to try and inculcate into our students the essential qualities of true sportsmanship, and we have every hope of success.

Sports.—In former years, the distribution of prizes took place some time in the month of November and the sports were held the day after.

These sports were more in the nature of a gymkhana to amuse the spectators, and very little training was done for them by the students. The school year having been recently altered to terminate in April, a month much too hot in Pyinmana for strenuous exertion, and there being now a prize for the best athlete, it has been decided to have the serious sports, for which marks are allotted in October, and a sort of pagal gymkhana in the following April in conjunction with the distribution of prizes. This year the sports took place on the 2nd October and the following are the events with the results :—

I. 100 Yards ...	1. Nai Samrid	... 11 seconds.
	2. Mg. Tun Nyein.	
	3. Mg. Maung II.	
II. 220 Yards ...	1. Nai Samarid	... $26\frac{1}{5}$ seconds.
	2. Mg. Ba Tun.	
	3. Mg. Ba Thaw II.	
III. 440 Yards ...	1. Mg. Ba Tun	... $66\frac{4}{5}$ seconds.
	2. Mg. Ba Tin.	
	3. Mg. Thaw II.	
IV. One Mile ...	1. Mg. Ba Tin	... 6 mins. $27\frac{4}{5}$ secs.
	2. Mg. Ba Thaw II.	
	3. Mg. Ba Kin.	

V. 120 Yards, Hurdle Race	...	1. Nai Samrid	... $18\frac{4}{5}$ secs.
		2. Mg. Napoleon	} Dead heat.
		3. Mg. Kin.	
VI. Long Jump	...	1. Nai Samrid	... 13'-8"
		2. Mg. Kin	... 13'-5"
VII. High Jump	...	1. Mg. Napoleon	... 5'-3½"
		2. Mg. Kin	... 5'-1"

It will be noticed that Nai Samrid, one of our new Siamese students, was the hero of the day and his performances were distinctly creditable. Napoleon's high jump was quite useful too, but he has beaten that height in practice, and would have done much better on the sports day if he had been fitter. The timings in the long races, *i.e.*, 440 yards and one mile, are capable of a great deal of improvement. It was very unfortunate for us and a piece of very bad luck on his part, that Willix, the strong favourite for these two events and Nai Samrid's most dangerous rival in the others, could not compete at all, as he crocked himself up two days previously by over-training. If fit, he would have assuredly lowered the timings in these long races by an appreciable margin. The times were taken by a stop-watch kindly checked and lent to us for the occasion by Messrs. P. Orr & Sons of Rangoon. We have every hope that the results in the coming years will be a great improvement on those of this year, as the sports just finished were the first of their kind held in the School, and appeared in the nature of an innovation to the students. They will now know when, how, and for what, to practise. To aid them in their practice, books containing hints given by the leading amateur sprinters and jumpers of Great Britain have been obtained and circulated for information, and practical advice is freely given by the staff. Further, besides the allotting of marks, as an additional zest to competition, valuable and useful prizes were awarded to the winners.

Marathon Race.—This great event took place on the evening of the 3rd October 1917, a day after the other sports. The course was along the cart-road from Pyinmana to Taungnyo. It was originally intended to start the competitors off at the 1st milestone, let them go up to the 6th milestone, and return to the first, thus

making ten miles in all. But as a result of the heavy rain which Pyinmana experienced during the end of September 1917, the road, which is metalled up to the 3rd milestone only, was found to be in a very bad condition on account of numerous lengthy bogs. The runners were, therefore, stopped 4 miles 2 furlongs from the place of starting and turned back. The length of the course was thus shortened to 8½ miles. Forty-eight students out of the sixty-five in the School toed the line for the start, and the following are the results :—

1. Mg. Ba Tin	... ...	1 hour 5 minutes.
2. Mg. Ba Thaw II	... ...	1 ,, 7 ,,
3. Nai Siri ...	... ...	1 ,, 9 ,,
4. Mg. Kyi Lwin	... ...	1 ,, 9½ ,,
5. Mg. Sharoi	... ...	1 ,, 10 ,,

The timing was satisfactory and it would very probably have been improved if Willix, who had trained himself thoroughly for this event, had been able to compete.

Judging from the number of starters and the great keenness displayed by the students, this race promises to be the most attractive and well-contested event in future years.

JAP LUMBER RESOURCES.

BY T. SINGTON, OF MARSDEN CHAMBERS, MARSDEN STREET, MANCHESTER.

Japan, as regards both soil and climate, is exceptionally suited for the growth of forest trees on an enormous scale. The area of forest land in Japan proper has been officially estimated to be 71,000,000 acres. The extent of the lumber supply was so vast that scientific forestry under State control was completely neglected until comparatively recently. Local conditions also contributed to that result: mountainous districts are so extensive as to render communication and transport difficult and native ideas of forestry were somewhat crude and primitive. But the recent development of commerce and industry in Japan has very greatly increased the demand for lumber for railways, ship-building and mining, as well as for general industrial purposes; for building, road-making and fuel. There is also a steadily increasing export

of lumber to Korea, Manchuria and China, countries with very limited forest areas. The gradual development of means of communication, both roads and railways, has given an impetus to forestry, which, under the present enlightened Government, is destined to become a very promising industry.

During the last complete year of peace (1913), the production of lumber in Japan amounted to £10,370,000. The quantity of lumber was 144,269,000 cubic feet, with smaller items such as bamboos and by-products. Land was afforested to the extent of 386,000 acres. There are three classes of forest land in Japan: those belonging to the State, those owned by the Imperial household and those privately owned. The areas are approximately as follows :—

		State forests.		*Imperial household.*
		Acres.		Acres.
1905	...	31,052,000	...	3,627,000
1910	...	27,170,000	...	5,225,000
1914	...	19,540,000	...	4,490,000

The forestry work of the State may be summarized as follows: the most recent enactments were promulgated in 1907, providing administrative authority to prevent the destruction of forests and to secure the planting of trees in both public and private forests as well as on waste land, exemption from taxation being granted where desirable. Utilizing forest land for cultivation may be restricted or prohibited. To make clear the relation between forests and weather, meteorological observatories have been established. Special bounteous subventions are granted for the restoration of waste public forest lands, which have been denuded of lumber in the past and not replanted. Boundaries are being mapped and areas surveyed. The quantity of timber which may be felled annually to satisfy the home and foreign demand for lumber is limited so that the future lumber supply may not be endangered.

Japanese forests may be divided into five zones: the torrid zone is the smallest, the sub-tropical. The principal trees are the "Ako" *(Ficus infectoria*, Roxb.*)*; "Takonoki" *(Pandanus*

odoratissimus, L.); "Binroji" (*Areca Catechu,* L.); "Bashobanana" (*Musa Basjoo,* Sieb.) and "Koroji" (*Arenga saccharifera,* Labill).

The second zone contains the forests lying north of 26½ degrees north latitude, extending northward approximately for 10 degrees. The area of the forests in this zone is a very large one, containing a great variety of trees. Many of the forests are within easy reach of larger centres of population and are therefore economically of great importance. The more important *evergreen* broad-leaved trees are the "Kusa" or camphor trees; the "Tsugo" (*Beedus* japonica*); "Akakashi" (*Quercus acuta*); "Shirakashi," or white oak; "Ichigashi" (*Quercus gilva*) and the "Ubamegashi" (*Quercus phillyræoides*). The trees with *annual* broad leaves are mainly "Kunugi" (*Quercus serrata*) and the "Konara" (*Quercus glandulifera*). The "Akamatsu" (*Pinus densiflora*) and the "Kuromatsu" (*Pinus Thunbergii*) are the most important of the needle—leaved trees. The Japanese forests of the temperate zone are situated between latitude 36 degrees and 43 degrees; the heights above sea-level range from about 4,800 feet to below 1,500 feet. The forests in this zone cover a great area of land and the scenery, owing to the mountainous nature of the country, is of extreme beauty. Most of the forests are natural, but several have been planted. In this area the absence of transport facilities is seriously felt but, in course of time, they may be provided. From 50 to 60 species of trees occur, both broad-leaved and needle-leaved; the latter include the "Sugi" (*Cryptomeria japonica*); "Hinoki" (*Cupressus obtusa*); "Momi" (*Abies firma*); "Tsuga" (*Tsuga Sieboldii*); and "Sawara" (*Cupressus pisifera*). The broad-leaved trees of the temperate zone include the "Buna" (*Fagus sylvatica*); "Kayaki" (*Zelkova acuminata*); "Katsura" (*Cercidiphyllum japonicum*); "Shioji" (*Fraxinus Sieboldiana*); "Kaedo" (*Acer pictum*) and species of Juglans, Prunus, Magnolia and Castanea.

The fourth is the frigid zone: it includes the northern half of the great island of Mokkaido and the whole of the island of Karafuto. The extreme height above sea-level reaches over 9,000

* *Buxus japonica ?*—[HON. ED.]

feet and over a considerable area is about 5,000 feet above that level. The following lumber trees may be mentioned :—

The "Shirabe" *(Abies Veitchii)*; the "To-hi" *(Picea hondoensis)*; the "Araraki" *(Taxus cuspidata)*; "Aomori-todomatsu" *(Abies Mariesii)*; the "Todomatsu" *(Abies sachalinensis)*; two species of "Yezomatsu" *(Picea ajanensis* and *Picea Glehnii)* and the "Shikotan-matsu" *(Larix dahurica)*.

The fifth zone is the most northerly; the climate is very severe and the lumber resources are very limited.

Some details of the estimated quantities of the more important trees available for export and industry and the conditions in which they occur may interest readers. Commencing with the Sugi *(Cryptomeria japonica)*, the quantity available for industrial purposes has been officially estimated to be 768,000,000 cubic feet by the Akita forestry department, which has the following forests under its jurisdiction :—Yatateyama, Nagakisawa, Haneyama, Nibunayama, Ojika-yama and others. The trees forming these forests have been growing for periods ranging from 130 to 160 years. The diameters range from one to two feet and the height generally exceeds 100 feet and the stems are very straight. In the district of Araodake there is a forest of the Sugi trees, under the management of another forestry department, growing mixed with *Fagus sylvatica*, the quantity of which is estimated to be 3,960,000 cubic feet. The Sugi also grows in many other forest areas under various forestry departments mixed with *Abies firma, Tsuga Sieboldii* and many other species of trees. This Sugi lumber is used for many purposes, the most important being house-building, bridge-construction and shipping; it is also used for posts for electric wires and furniture; it has a beautiful grain and lustre. Another important Japanese lumber tree is the Hiba *(Thujopsis dolabrata)* of which there are estimated to be over 400,000,000 cubic feet available. Trees of this species are not limited to any special areas, they grow everywhere under very varied conditions. The age of the trees ranges from 100 to 150 years; the diameter may be four feet, and the height 60 to 90 or more feet. In many localities, the trees are of fairly uniform size and age and occur in dense

forests. This lumber is useful for many engineering purposes, as it is strongly impervious to water and when employed in the construction of vessels and harbour works under water has been known to last eighty years. It is largely used for railway sleepers and has been found to be sound after the lapse of twenty years.

The available quantity of *Tsuga Sieboldii* exceeds 332,000,000 cubic feet; many of the forests containing this tree are mixed, a variety of trees growing together; some of the other trees being *Larix leptolepis*, *Picea hondoensis*, *Pinus parviflora* and others. The Tsuga lumber average 150 years in age; the diameters range from one to two feet and height generally exceeds 70 feet. In some forests, the other trees are several species of Abies. The Tsuga lumber is described as being of good quality and very impervious to water; it is extensively used for building purposes; also for paper-making, railway carriages and boxes. Another very useful lumber tree is the Momi *(Abies firma)*; the estimated quantity is 204,000,000 cubic feet. The stems of these trees are straight and of great size; the diameter may extend up to five feet, with a height of 90 feet. Generally, the growth is luxuriant, there being long under-branches, with few knots, the lumber is good both in form and quality. This lumber is very suitable for cutting into boarding as it has a straight grain; it is very extensively used for a variety of purposes, such as for tea-chests, while it is also employed for paper-making.

A very much used Japanese lumber tree is the Akamatsu *(Pinus densiflora)*, the available quantity of which has been estimated to be about 200,000,000 cubic feet. Many of the forests are mixed, some of them may contain the Pinus trees to the extent of 80 per cent., miscellaneous lumber making up the remaining 20 per cent. The trees vary in age from 70—140 years; the diameter may extend up to four feet and the height varies from 50 to 130 feet. The lumber is a favourite with the native population and is used for many purposes in the industrial arts. It withstands the weather and is consequently extensively used for building and decorative purposes. Another very popular lumber tree is the

Hinoki ; this lumber is strong and flexible, with a straight and lustrous grain and a pleasant aroma. It is easily worked and does not readily split, and is very extensively used for architectural purposes, ship-building, cars and utensils in ordinary use. As regards demand and superiority of quality, it may be considered the most important of the Japanese lumber trees. The tree known as Karamatsu is rich in resin ; it is impervious to damp and is consequently extensively used for bridge-building and ship-building. Another species of lumber Himekomatsu is generally used for interior joiners' work. So much for the trees with needle-shaped leaves of the pine and fir types.

Of the broad-leaved trees of Japan, special reference may be made to the Buna *(Fagus sylvatica)*; the available quantity may be estimated to be 3,400,000,000 cubic feet ; it is the most abundant of the Japanese forest trees. Many forests are practically limited to this one species of tree, their ages vary from a hundred years to twice that period ; diameters range from 1 foot 6 inches to 2 feet 6 inches, and the height from 60 to 80 feet. Some of the Buna forests have a mixture of oak trees. The forests extend over the mountains as well as the lower ground ; this lumber decays in water ; it is generally used for fuel. Some varieties are used for handles, clogs and household utensils. The lumber may, however, be treated with chemicals and is then available for railway sleepers. A species of oak tree, Mizunara *(Quercus grosseserrata)* occurs to the estimated extent of 410,000,000 cubic feet ; the diameter reaches five feet and the height 50 feet ; the forests are generally mixed, other trees being Walnut, Magnolia, Acer and others, such as chestnut. The lumber of this oak resembles chestnut, but is somewhat harder, with a rough grain ; when dried, it bends and splits easily and though it grows to a large size, it cannot be made into planks. It grows in great abundance where means of transport are lacking, consequently its use has not been developed ; but if the lumber is dried by steam, so as to prevent splitting in accordance with American practice, it may be rendered serviceable for making implements and utensils, for ship-construction and for railway sleepers.

The Horse-chestnut, Tochinoki *(Aesculus turbinata)* occurs to the extent of 670,000,000 cubic feet and grows at all elevations on mountain ranges, as well as in the plains, in forests mixed with a great variety of other trees. The diameters range up to 1 foot 6 inches and heights 40 to 50 feet. This lumber has not been extensively used, but it is easily worked, its grain is beautiful and lustrous, and it can be lacquered for decorative purposes and carving. It is used for implements, household goods and other minor purposes.

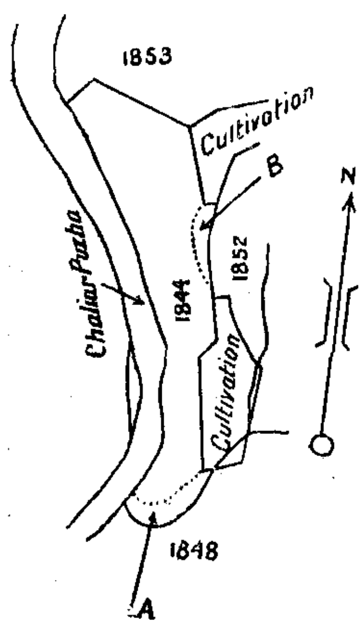
EXTRACTS.

Extract from the Experiment Register, South Malabar Division. Natural Regeneration of Teak under Uniform Methods. Entry of 1917-18 *by the District Forest Officer, South Malabar.*

* * * * *

In the clear felled plantation area of this year, *i.e.*, Aravillicava plantation, 1844, in the areas previously stocked with teak, a fairly profuse natural regeneration of teak was obtained. It was, however, very irregularly and unevenly distributed. At a rough estimate, there would be no acre with less than 100 seedlings, while in patches they came up so thick that you could hardly step without treading on them. The monsoon set in in the second week of June. These seedlings first appeared in the last week in June and were noticeable in the first week of July. The whole area was planted up between 14th and 27th June, partly 6½′ × 6½′ and partly 6′ × 6′. The first weeding was commenced on 16th July and the area was practically clear weeded without damaging, as far as possible, any of the natural seedlings. This weeding was costly in any case and was made more costly by the smallness of these seedlings (under 6 inches) and the difficulty of seeing them among the weeds. Taking the area as a whole and considering first its orientation, it is distinctly noticeable in the two areas on which, for a considerable period in the morning, shade is cast by the adjoining plantations, which are 90′—110′ high, not only that there are no natural seedlings within the area lying in shade after

SKETCH
4" = One Mile



about 8—9 A.M., portions marked approximately in the sketch in dotted lines and lettered A & B, but also that the planted seed lings are not growing as fast as those which are more in the open. This latter phenomenon has been noticed before, but has been put down more to drip than to shade. It is certain that the plants on the very edge are effected by drip in any case. This is easily illustrated by inspection of the northern edge of a young plantation bordered by old plantation or by big natural forest. It is most emphasized in the second and third years, when the current annual height increment in average I quality is as much as 8 feet and 11 feet respectively. The breadth of the strip so affected, however, is never more than about 60 feet while it is generally not more than 30 feet. In very best I quality, at the end of the second year there may be often a difference of 12 feet in the height of plants growing on each side of this narrow strip. In the areas A & B in the sketch, however, the breadth affected and devoid of all natural regeneration is, in places, as much as 130 feet. It is certain that shade alone in a part of these areas has affected the natural regeneration and the rate of growth of the planted seedlings.

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THE WATER ELEPHANT.

(*From the "Rangoon Gazette," dated 8th November* 1917.)

SIR,—In your issue of to-day reference is made to the re-appearance of that old fraud, the Ye Sin, or water elephant.

This is a piece of very clever camouflage on the part of the unsophisticated jungle Burman and deceives most people who do not understand that the existence of such an animal is a natural impossibility. The *modus operandi* is this: A frog is disembowelled, and the brain cavity emptied out. The head covering is then moulded to the required shape, and redundant skin supplies the ears and trunk. Then bone tusks are fitted.

The hind legs are disarticulated and their position reversed so as to give the forward position of the knee. The feet are cut away and the whole thing is sun-dried. The Burman does not wish to sell this priceless mascotte, but endeavours to borrow money on it on account of alleged temporary financial difficulties.

Needless to say that, as frogs are cheap, the specimen is never redeemed.

R. R. PEARSE.

CHINESE PLANTS IN AMERICA.

The camphor tree is one of the many plant importations from China that promise much in the United States. The trees grow well in hedges 15 feet apart in the South, and the average of eight tons of clippings per acre yields, on distillation, about 200 pounds of camphor. This means a present profit of more than $150.—[*Capital.*]

AEROPLANE FORESTRY.

As a substitute for the forester's watch-tower, the aeroplane has proven so successful that it is said a forest fire as much as 60 miles away can be detected by the aviator from a height of 1,500 feet.—[*Capital.*]

[The distance in miles (D) of the observer's horizon can be ascertained with fair accuracy from the formula $D^2 = \frac{3}{2} H$, where H is the height of the observer in feet, above the general level of the surrounding plain. At the same time it must be borne in mind that the smoke rising from a forest fire might be visible when the site of the fire was actually below the horizon—HON. ED.]

DOMESTIC OCCURRENCES.

BIRTH.

WALSH.—On November 10th, 1917, at Maymyo, the wife of H. L. P. Walsh, I.F.S., of a son.

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EFFECT OF STORAGE ON SOME TANNING MATERIALS.

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER, FOREST RESEARCH INSTITUTE.

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Introductory.

Little information is available to indicate the effect of storage on tanning materials and extracts, though it is well known that when stored in such a manner as to be exposed to atmospheric moisture and oxidation such materials are subject, more specially if in powder form, to rapid deterioration, due to the formation of various oxidation products known as "insoluble reds" and "blacks."

This enquiry was initiated with a view to obtaining definite information as to the degree of deterioration caused by storage in laboratory store rooms where, with the exception of *Acacia Catechu* heart-wood, all specimens examined had been kept in gunny bags, wooden boxes and paper envelopes subsequent to being thoroughly air-dried.

In actual practice, for bulk samples, similar storage conditions could only be obtained by packing in air-tight cases, or in such an envelope as would ensure protection from the injurious effects of moisture, sunlight, fermentation and fungus attack. It is hoped that the information given below may be of use to tannin extract manufacturers or dealers in tanning materials who have recourse to storing materials for prolonged periods.

Effect of storage on the heart-wood of *Acacia Catechu.*

The heart-wood of *Acacia Catechu* is the familiar source of the "katha" of the Indian bazaar and is composed of 'catechin' and 'cutch.' The latter consists mainly of Catechu tannic acid which is so largely exported to the United Kingdom for dyeing fishing nets. Catechin is a very unstable substance, liable to rapid decomposition when exposed to moisture or heat, the effect of more heating being to convert it into Catechu tannic acid and other products.

The writer has had the opportunity of examining the heart-wood of *Acacia Catechu*,* and the results obtained have already been published. The table on the next page gives the composition of some of the woods examined.

* See *Indian Forester*, Vol. XXXVIII, 1912, pp. 154—156 and Vol. XLI, 1915, pp. 482—485.

Serial No.	Description.	Moisture per cent.	Catechin per cent.	Alcohol extract per cent.	Acqueous extract per cent.	Nature of the solids left on distillation of alcohol from the alcoholic extracts.
1	*Acacia Catechu* heart-wood from the Siwaliks, girth 4′ obtained and examined in 1907.	Fresh 24·40 Air-dried 7·50	8·78 10·90	11·04 13·70	17·58 21·80	A portion was soluble in cold water, consisting mainly of Catechu tannic acid and the insoluble portion examined under microscope consisted mainly of Catechin.
2	Sample No. 1 kept in the form of a large piece and examined in 1911.	10·86	...	9·31	8·54	Almost wholly insoluble in cold water, and the insoluble portions as examined under microscope were "insoluble reds" and not Catechin.
3	A forty years' old specimen of the heart-wood of *Acacia Catechu*, from Garhwal, Kumaun, obtained from the Forest College, Dehra Dun, and examined in 1911.	8·11	...	5·44	10·00	Do. do.
4	A piece of the heart-wood of a tree found dead in the forests, received from Madras.	8·23	2·56	9·76	12·72	Catechin was present as seen under the microscope.
5	A piece of the heart-wood of a tree found dead in the Siwaliks.	9·58	1·48	12·38	16·40	Do. do.
6	A piece of the heart-wood of a tree killed *in situ* by girdling, from the Siwaliks.	17·50	4·02	10·18	12·05	Do. do.
7	A sample of the heart-wood of a typical tree of *Acacia Catechu* growing on the sturdy slopes of sand-hills of the eastern part of the Bikaner State, received and examined in 1910.	11·26	...	2·41	9·18	Catechin not present; only a little Catechu tannic acid and insoluble reds.
8	Another sample do. do. ...	12·76	...	2·10	5·42	Do. do.

From the table, it will be seen that the heart-wood of *Acacia Catechu*, when stored for a long time or allowed to be exposed to atmospheric action in the forest (*vide* samples Nos. 4, 5 and 6 of dead wood), loses or tends to lose all its Catechin and even the Catechu tannic acid contained in the wood is further oxidized into "insoluble reds." The sample No. 1, obtained from a log which was allowed to lie about without being cared for, had lost all its Catechin after a period of four years. It is extremely interesting to see the close agreement between the composition of sample No. 2 and No. 3 which had been lying for forty years in the museum, and how the percentage of Catechin in samples Nos. 4, 5 and 6 tends to fall owing to atmospheric action in the forest. It is also remarkable that a tree of the same species which had been growing in a dry and sandy locality was devoid of its usual content of Catechin. In the papers already cited, an explanation was offered as to the cause of this deterioration. Owing to the great ease with which Catechin decomposes when exposed to moisture and sunlight, it was argued that the loss on storage of *Acacia Catechu* is mainly due to the formation of oxidation products and their final anhydration. It now transpires that, in certain cases, the deterioration which the wood undergoes can be traced to fungus attack, as old *Acacia Catechu* heart-woods have been found attacked by fungus with little else than cellulose left of them. On the other hand, of the samples examined in connection with this enquiry, one sample as old as forty years still gives a 10 per cent. aqueous extract and 5·44 per cent. alcoholic extract, thus indicating that deterioration is possibly due to the natural decomposition of Catechin and Catechu tannic acid, while the figures derived from the Bikaner specimens seem to show that the extreme dryness of the climate and hot winds of Bikaner produce the same change as is brought about by long storage in the case of other samples.

These results prove that the heart-wood of *Acacia Catechu*, if stored for a long time or allowed to "weather" in the forests loses most of its Catechin and Catechu tannic acid and thus becomes unsuitable for the manufacture either of *katha* or *cutch*.

Pods of *Acacia arabica*.

The pods of *Acacia arabica* furnish a valuable tanning material which has not hitherto been used in the tanning industry as extensively as it might have been, the chief defect being its extreme liability to fungus attack resulting in a dark coloured leather. The writer has succeeded in discovering a cheap and efficient preservative for the tan liquors obtained from this material and a final report on the subject is under preparation. But as this material is only available for collection at one season of the year, it seemed advisible to ascertain to what extent it could stand the effects of ordinary air-dry storage. The following table gives the results of analysis of one sample of Babul pods which were kept in a gunny bag under observation for a number of years, the pulp alone being taken for analysis as required :—

Serial No.	Description.	Moisture per cent.	Total soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin per cent. calculated on dry material.
1	Pulp of a sample of Babul pods received from Poona and examined in July 1910.	13·55	51·97	29·00	22·97	26·57
2	Pulp of a sample of Babul pods received from Poona and examined in June 1911.	8·43	36·88	13·62	23·26	25·40
3	Pulp of a sample of Babul pods received from Poona and examined in November 1915.	10·64	18·96	10·94	8·02	8·98
4	Pulp of a sample of Babul pods received from Poona and examined in October 1917.	9·73	28·24	17·88	10·60	11·47

From the above, it would appear that the pods, if air-dried and stored, keep fairly well as regards their tannin content for a year, though there is a noticeable fall in the total "soluble solids." This might be an advantage in the preparation of tannin extracts from the one-year-old pods. The same sample, when re-examined in 1915 and 1917, had only about 10 per cent. of tannin. This deterioration has been traced to fungus attack. The tannin in

these pods occurs as a thin lining inside the pericarp which is hard and scaly and, in the case of many individual pods examined, this thin layer of tannin was found to be absent and in others more or less damaged by the presence of fungus. This fungus may have been originally present in the pods themselves or may have obtained access from the air while the pods were in a green state. From the nature of the occurrence of fungus in the pods, it seems likely that it was already in the pods, though it cannot be definitely stated when and how the fungus attacks the pods, and this aspect of the subject needs further investigation.

Myrabolans: Fruits of *Terminalia Chebula.*

The following samples of ripe and half-ripe fruits of myrabolans were kept in the form of powder in paper envelopes and examined on various dates. The results show that the deterioration due to storage is negligible:—

Serial No.	Description.	Moisture per cent.	Total soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin per cent. calculated on dry material.
1	A sample of myrabolans collected in October 1912, from Madras, and examined in October 1914.	9·32	70·60	12·07	58·53	64·55
1 (*a*)	Ditto examined in 1917.	15·40	68·96	14·11	54·85	64·83
2	A sample of myrabolans collected in June 1913, from Madras, and examined in October 1914.	16·43	66·20	19·10	47·10	56·34
2 (*a*)	Ditto examined in October 1917.	12·87	62·80	16·93	45·87	52·64
3	A sample of myrabolans collected in October 1912, from Madras, and examined in October 1914.	13·89	61·80	16·06	45·74	53·12
3 (*a*)	Ditto examined in October 1917.	11·23	59·60	15·34	43·86	49·34
4	A sample of myrabolans, from Bombay, examined in June 1911.	9·34	63·94	13·55	50·39	55·58
4 (*a*)	Ditto examined in August 1912.	16·52	64·00	17·90	46·10	55·82

Serial No.	Description.	Moisture per-cent.	Total soluble solids per cent	Non-tannin per cent.	Tannin per cent.	Tannin per cent. calculated on dry material.
5	Half-ripe myrabolans, from Bombay, examined in June 1911.	8·59	66·64	16·80	49·84	54·52
5 (*a*)	Ditto examined in August 1912.	16·82	61·92	20·20	41·72	50·15
6	A sample of myrabolans, from Bombay, examined in June 1911.	8·25	66·88	15·20	51·68	56·63
6 (*a*)	Ditto examined in August 1912.	16·72	66·08	17·95	48·13	57·79
7	A sample of myrabolans, from Bombay, examined in June 1911.	9·61	63·96	15·95	48·01	53·11
7 (*a*)	Ditto examined in August 1912.	16·35	62·12	16·95	45·17	54·00

Mangrove and other barks.

Two samples of mangrove bark (*Rhizophora mucronata*) obtained from the Andamans were kept under observation, one was roughly powdered and kept in a gunny bag, the other being preserved in its original state. The results obtained are given below :—

Serial No	Description.	Moisture per cent.	Total soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin per cent calculated on dry material.
1	Bark of *Rhizophora mucronata*, from Andamans kept in powder and examined in February 1912.	10·37	32·12	8·7	23·42	26·17
1 (*a*)	Ditto examined in October 1917.	15·69	32·16	8·68	23·48	27·85
2	Bark of *Rhizophora mucronata*, kept in bark, examined in 1911.	8·84	45·88	8·01	37·37	40·99
2 (*a*)	Ditto examined in 1915.	12·02	42·80	7·60	35·20	40·10

These results indicate that mangrove barks do not undergo any further deterioration after they have been once air-dried and stored.

Some of the other barks kept under similar condition gave similar results showing no deterioration :—

Serial No.	Description.	Moisture per cent.	Total soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin per cent. calculated on dry material.
I (1)	A sample of Babul (*Acacia arabica*) bark examined in December 1910.	8·43	21·47	10·09	11·38	12·42
1 (*a*)	Ditto examined in October 1915.	9·41	19·84	8·18	11·66	12·87
II (1)	A sample of bark drawn from a young Sal (*Shorea robusta*) tree examined in July 1911.	7·88	27·36	9·12	18·24	19·80
1 (*a*)	Ditto examined in June 1912.	12 91	22·56	8·38	14·18	16·28
1 (*b*)	Ditto examined in October 1917.	10·61	22·21	8·16	14·05	15·71
III (1)	A sample of bark of *Cassia auriculata* examined in July 1910.	12·46	31·34	10·92	20·42	23·32
1 (*a*)	Ditto examined in June 1911.	8·32	29·48	7·60	21·88	23·86
1 (*b*)	Ditto examined in June 1915.	9·89	32·06	10·62	21·44	23·79
IV (1)	A sample of bark of *Acacia pinnata* examined in July 1910	12·37	15·39	7·12	8·17	9·32
1 (*a*)	Ditto examined in June 1911.	9·32	15·55	6·80	8·75	9·64
1 (*b*)	Ditto examined in August 1912.	12·88	12·16	4·24	7·92	9·10
V (1)	A sample of bark of *Terminalia tomentosa* examined in June 1911.	5·39	17·87	5·87	12·05	12·73
1 (*a*)	Ditto examined in April 1915.	7·81	14·32	3·36	10·96	11·88

Effect of storage on tannin extracts.

Simultaneously with these experiments, four samples of tannin extracts were kept under observation. They were packed in wooden boxes and kept in the store room with the other samples. The following table gives the results of their periodical examination :—

Serial No.	Description.	Moisture per cent.	Total soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin per cent. calculated on dry material
1	Mangrove tannin extract, made by the writer at the Rangoon Tannin Factory (since dismantled), examined in March 1911.	32·00	68·00	14·8	53·20	78·29
1 (a)	Ditto examined in October 1917.	14·60	85·40	26·04	59·36	69·50
2	Tannin extract made from the bark stripped from young Sal (*Shorea robusta*) tree, made by the writer, and examined in April 1911.	47·2	52·10	16·20	35·90	68·00
2 (a)	Ditto examined in October 1917.	17·17	82·20	34·94	47·26	57·05
3	Tannin extract from the bark stripped from old Sal trees, made by the writer at the Rangoon Factory, and examined in April 1911.	47·40	52·70	21·60	31·1	89·12
3 (a)	Ditto. examined in October 1917.	14·83	81·20	36·67	44·53	52·04

Summary of results.

In conclusion, it may be stated that in spite of the extremely oxidizable nature of the "tannin" as it occurs in woods, barks and fruits, it is safe to assume that, except in the case of the wood of *Acacia Catechu* and the woods and barks and fruits attacked by fungus, the tanning materials in general preserve their tannin strength for more than three years if stored air-dry in properly ventilated rooms, in such a way as not to be exposed to the attacks of fungi or insects. The samples of tannin extracts examined, on

the other hand, show a marked decrease after a long storage of about seven years, especially the Sal extract made from the bark stripped from old Sal trees, but this is mainly due to the fact that the original extracts were not stored in an air-dry condition.

WANTED—A FOREST POLICY FOR ASSAM.

BY A. J. W. MILROY, I.F.S.

The two articles on Forestry in Burma, which appeared in the *Indian Forester* for September 1916, must have come as a surprise to anyone acquainted with forest conditions in Assam, so closely do the descriptions apply.

The causes, which have given rise to this unsatisfactory state of affairs, are probably similar in both provinces. Forestry all over the Empire, as well as in India, is handicapped from the very outset by the Britisher's want of knowledge of, and consequent lack of interest in, the subject.

The peoples of the Continent are brought up with forests at their doors; for generations, they have appreciated the economic value of forests to the State and to the individual, while a sentimental attachment to the charm and mystery of great woodlands seems to be innate, and has given birth to so much of their folklore and to so many of the fairy stories that have been translated and adapted for English children.

The Britisher, on the contrary, is born in a land without forests or forest tradition, without a rural population looking to the forest for a livelihood, or towns and villages trusting to the profits from their communal woods to relieve the burden of local taxation: circumstances, in fact, have prevented him from coming in contact with forest questions; he has cheap coal for his fire and spare cash to buy his pit-props and building timber from abroad.

I know that personally, three years before I landed in India, I regarded woods as little more than useful sources for the supply of foxes, primroses and hurdles, and as beneficial natural phenomena only so long as they were not too extensive for satisfactory hunting.

The amount of unadulterated ignorance that the Forest Department in India has had to fight from the days of Brandis onwards must be stupendous but, on reflection, not surprising. The difference between the English and the Continental attitude towards this subject was well illustrated by the French who, with the invader at the very gates of Paris, protested against the British troops firing the forest of Compiègne to drive out the Germans.

The convenience, if not the importance, of conserving timber supplies must have been impressed on the individual official mind in the older provinces of India at an early date, when the establishment of law and order by the British encouraged an increase of population and cultivation, and resulted in the complete obliteration of forests over vast areas. The demands of railways for sleepers in increasing numbers must, at the same time, have shown Local Governments that their provinces, unlike England with Canada on one side and the Baltic on the other, needed forests to help them in their advancement. Enthusiastic encouragement was not a feature in any province, but circumstances in India proper must have demonstrated that forestry had its uses.

Conditions in Assam, and presumably in Burma too, were and are quite different and have proved inimical to the progress of forestry and the realization of its importance.

When we first took over Assam, the population in the plains was small and the stretches of cultivation were separated from each other by unhealthy, uninhabited and apparently useless forest, so that a policy of opening-out at the expense of the forest was embarked upon and exists to the present day.

This policy was the natural and obvious one, but its results would have been more advantageous if it had been pursued less blindly. No care was exercised to see that the extension of cultivation proceeded in an orderly manner, and squatting was not adequately discouraged. There may be nothing theoretically against irregular squatting, but in practice it has proved most destructive to the forests without yielding compensatory benefits. The squatters are either individuals, who make a small, and often only temporary, clearing in the forest, or a number of families,

who combine to form a hamlet. There is something to be said for the latter, who actually do break up land for permanent cultivation, but the former, usually ex-garden coolies of the jungly Jats do a great deal of material and quite unnecessary harm. In either case the squatters manage to spoil a surprisingly large area of forest.

One or two Munda or Sontali families will devastate a square mile of forest within a couple of years, so that a few scattered settlers can ruin a whole block of forest, the bulk of which would have remained untouched, if they had been made to clear land on the fringe. The Gurkhali grower of sugar-cane is a 'jhumer,' pure and simple, and his depredations are much resented in the proximity of tea-gardens, for he takes all the good out of the soil in addition to felling and burning the timber that formerly grew on the site.

It is a little difficult to understand why the advantages of creating reserves in the midst of cultivation and blocks of tea have not been more obvious in the past; the great extent of forest area seems to have given rise to a mistaken impression that it was inexhaustible.

Our records show that the Local Administration and, more especially, the Government of India were able to take a broader view of matters than many of the local officials.

The Government of India, indeed, have, from time to time, exhibited mild surprise at the small percentage of waste land reserved. The policy of reserving forests was given effect to in many cases, one feels, more as a concession to superior authority than from a conviction that anything useful was being achieved, and it is not surprising to find that our oldest reserves, other than those containing Sal, are generally situated in the remotest places.

The gradual elimination of the old-style Assam District Officer with his old-style prejudices has allowed some extensive and valuable reserves to be formed in quite accessible areas during the last 6 or 7 years, but this encouragement has come too late for some districts, and planters have already been asking for help in the establishment of fuel plantations. The War affects us principally in two ways, and as it may confidently be predicted that a

new era in forestry will commence on its termination, the moment is opportune for taking stock of the situation. In the first place, one of its lessons has been that more attention must be given to the conservation of the natural resources of the Empire, and this province is favoured with a supply of timber and other forms of produce, such as bamboos and grass for paper-pulp, that constitute a distinct Imperial asset.

In the second place, we can hardly doubt that a larger measure of local self-government will follow the War, and it behoves us to try and see in advance how this will affect our interests. The first matter that claims our attention, when considering how best we can preserve and utilize our resources, is the establishment of new reserves.

An order was issued in Cachar some years ago that no new leases were to be given out in certain specified areas, where a considerable amount of waste land was known to be still remaining, without the Forest Department being consulted first. Cachar is fairly thickly populated, and the order was issued because the inconvenience resulting from the uncultivable waste lapsing into useless scrub was becoming apparent. The order came too late to do much practical good. With this example before us, the issue of a similar rule for the Assam Valley districts has been asked for, because here we will be in time to save much valuable forest from being frittered away without anyone being a penny the richer. But any reservation programme is liable to serious curtailment or postponement under the existing method of procedure.

The District Officer is generally appointed Forest Settlement Officer, and his views are practically the deciding factor as regards the fate of the reservation proposals, with which he has to deal. He may accept or reject the proposals *in toto* or abridge the extent of the area to be reserved.

There is nothing startling in all this except the initial assumption that the Forest Settlement Officer is competent, from instruction or observation, to express an opinion, and can bring an open mind to bear on the matter.

When I first came to Eastern Bengal and Assam, there were still a few officials, who were uncompromisingly against any extended forest policy, and who said so.

There were others who were decidedly suspicious of our intentions. The great increase that has been made in the area of the reserves within the last few years bears witness to the increased enlightenment with which the subject is now treated, but the absence of a definite and guiding policy still leaves us a prey to individual opinions and at the mercy of the Great Parish Pump Policy.

Parish Pumps can be erected or removed according as they appeal to or repel the local powers-that-be, but it is difficult to replace forests that have been removed.

The following affords an interesting and instructive example. A Deputy Commissioner formed an idea of the importance of certain hills remaining afforested for the prevention of floods in the plains below. He was ignorant of the silvicultural value of the forests and, accordingly, took the divisional forest officer with him on a tour of exploration. As a result of this examination, the forest officer was instructed to draw up proposals for reservation. This was done, but the district officer was transferred before much progress could be made.

His successor viewed matters in a different light and considered that the hills should remain open for the accommodation of some 'jhuming' families and, being appointed Forest Settlement Officer, so mutilated the original proposals that they were no longer acceptable to the Conservator. He, mindful of the department's lugubrious motto, had no better alternative than to sit tight and avoid a definite order against reservation. I do not pretend to say which Deputy Commissioner was right and which wrong in this particular instance, but I do say that we can no longer afford to treat a large extent of country, such as was for disposal here, under a Parish Pump Policy.

The accident of a transfer prevented the area from being taken up, but it is possible that a similar accident will lead to the forests being reserved, considerably deteriorated meanwhile by

the 'jhuming.' A lick of paint renovates the discarded pump, but it may take a century of conservancy to remove the traces of 'jhuming.' The truth is that the Forest Department in Assam has only achieved what it has by resorting, in many cases, to mild diplomacy, or, if you like it, to trickery.

We knew in advance whether or not the district officer would be sympathetic towards an extension of the reserves in his district, and regulated our procedure accordingly, showing activity where it was likely to be fructuous, and masterly inactivity where it was denoted as the only line to take. Where the district officer belonged to the compromising genus, we gave him scope by asking for more than we wanted, and thus he was able to please both parties, the opposition by reducing the extent of the area, and the Forest Department by leaving us just about what we were out after.

It must be admitted that antagonism to the work of the Forest Department was not entirely unreasonable. We reserved large tracts of evergreen forest without having any clear ideas of how they should be treated silviculturally, we could hold out no immediate hope of their producing revenue, and we could not point definitely to any market that they were designed to supply, so that those, not gifted with the ability to see far beyond their own noses, may be excused for their averseness to furthering schemes for enclosing yet more land.

Thanks largely to the changed conditions resulting from the War, exploitation from the Assam evergreen forests is likely to commence at once and on a scale exceeding our wildest dreams. The problem hitherto before us has been how to extract the few saleable species and yet, at the same time, maintain or increase their proportion amongst the unsaleable species, perforce left standing; luckily, there is a prospect of the market being able to absorb all it can get, a state of affairs that the most sanguine forest officer had scarcely hoped to see in his time. Such a promising prospect of Rupees, annas and pies should prove convincing to anyone, whom the War has not converted to rational views on the forest question, and it is impossible to suppose that support

and encouragement will be withheld from our efforts in the future but only a definite policy, arrived at after a general interchange of ideas, can show us what we are to aim for, and how we can hope to accomplish our object.

It is supremely necessary for us to decide whether our forest policy is merely to serve provincial ends, or whether we mean to contribute, by preventing waste of our present wealth, to the needs of the Empire. The latter ambition attracts the forest officer, the former is possibly more alluring to the district officer. The fact that a world-shortage of timber is bound to make itself felt in the not far distant future is familiar to forest men. The supposed inexhaustible resources of North America and Siberia are known to be myths; it is true that comparatively vast areas of untouched forest remain, but past experience makes it certain that, once communications have been improved, the forests will be cut into with startling rapidity. In India alone there was reckoned to be a shortage of over ten million sleepers last year. With such facts before him, the forest officer cannot but feel that the situation should no longer be dealt with in the casual manner of the past, where everything just took its chance, and though civilization can be relied on ultimately to find suitable substitutes that is no justification for us to neglect present opportunities.

Increased reservation would, on the other hand, be viewed with disfavour by the native communities of the province, both educated and uneducated, because many of the excessive privileges they now enjoy would be curtailed, and for this reason district officers, with the quiet and peace of their districts at heart, might be tempted to oppose any measures provocative of temporary discontent.

In either case there is no disputing that the interests of the cultivator must be paramount in cultivable areas; it is the disposal of remaining waste land that furnishes the debatable point. It is inconceivable in these days that a strictly provincial decision, unfavourable to the expansion of forestry, could be arrived at, and expansion, as well as development, must be our declared policy.

Lack of men and money is a perennial disadvantage, under which many industries and departments have to labour throughout India, and the number of remedial measures suggested must have used up quite a lot of ink without bringing a practical solution of the problem any nearer. We already suffer on this score and must expect to. More direct obstacles to expansion are local opposition in the plains and 'jhuming' cultivation in the hills. It can be confidently predicted that the mere enunciation of a policy will not prove effective in achieving results unless a uniform method of dealing with objections to reservation can be determined upon to suit conditions in the plains. Uniformity is conspicuously absent at present.

A reservation proposal was hung up a few years ago by the Deputy Commissioner, acting as Forest Settlement Officer, on account of the number of objection petitions sent in, which he apparently accepted at their face value. He was transferred from that district, however, before the proposals had been finally negatived, and the matter was put before the new Deputy Commissioner. He found, as the result of less superficial enquiries not only that a fair proportion of the objectors had never had occasion to visit the lands, whose reservation they opposed, but also that not a few had only the vaguest ideas as to the exact direction in which the area was situated.

Here again we are obviously up against the old Pump Policy. The instance I have quoted is, perhaps, an extreme one, but there is no doubt that the most frivolous objections are sometimes regarded as valid by Forest Settlement Officers, and the Forest Department has suffered severely in consequence. There is nothing more disheartening to anyone, who tries to see a little further afield without at the same time being blind to local requirements, than to find this undue deference paid to complaints that should never be considered, much less upheld. District officers at the present time hold the most divergent views as to what complaints should be treated as genuine. I once heard a Deputy Commissioner tell a scandalized Assamese, nursed in the old traditions, that if it was a God-fearing country the whole of

that part of the district would be reserved, and such land as was fit would be given out to the cultivator, instead of us having to go poking about to find little patches that we could reserve without treading on anybody's toes : there are few, however, who hold such advanced views. A previous Local Administration decreed that, as a temporary measure, all settlement-holders (*i.e.* ryots) in the Assam Valley could exercise certain privileges in the waste lands, such as grazing their cattle free, removing thatch, firewood, dead poles, etc. It was carefully laid down that no rights were conceded, and as there has been no further legislation or ruling on this subject one would have supposed that there was no room for differences of opinion : this is not the case. The ryot, not discerning the difference between a privilege and a right, is inclined to think he has a right.

Cases have occurred of district officers considering that the privileges have now become rights consequent on long enjoyment. Circumstances may compel a subsequent Local Administration to change or cancel regulations made by a previous Administration, but that individuals should take it upon themselves to do so appears to be a most unwarrantable and dangerous assumption of powers.

Some officers consider that it is hard luck on the people to interfere with the complete enjoyment of the privileges, which they have exercised for so long, an apparently quite unjustifiable interpretation of Government's wishes, and equivalent to acknowledging rights.

Forest officers, it may be suspected, err on the side of intolerance, and wish to bring reserve boundaries right up to peoples' back doors, a proceeding not calculated to soothe ruffled feelings.

Nowadays, when this branch of administration is regarded more seriously, we can count on the majority of Forest Settlement Officers considering each case strictly on its merits, and, though nothing is more despicable than compromise for the sake of compromise, much can often be affected by judicious compromise and to the advantage of all parties.

The Forest Department, itself, does not seem to recognize the real hardships that fall upon ryots, when the adjacent waste land is suddenly closed to them, to be managed thenceforth under a working-plan, that only deals in big things like annual coupes, felling series, contractors, etc., and takes no account of the poor man at its gates.

In some recent settlements in this division, it has been arranged that the villagers should continue to satisfy their simple wants from the newly-formed reserves, in exchange for maintaining certain lengths of boundary lines free of cost, and it is believed that the villages will, on the one hand, be assured a permanent supply of produce (which would not be the case if the forest had been left exposed to their unrestricted depredations), and that the Forest Department, on the other hand, will benefit by having satisfactory boundaries of its own choosing, cleared yearly without trouble.

Mutual arrangements on these lines can be commended, where villages are small and the cultivation cannot unduly increase, always provided that the reserve can be sufficiently safeguarded against the privileges becoming excessive.

This division (Kamrup) affords a number of instances of injudicious compromise, where villages, completely surrounded by reserve forests, have been excised by short-sighted Settlement Officers at the instance of equally short-sighted villagers. These latter have had to come to terms with the Forest Department, because their cattle will stray, and because they have exhausted, in their customary wasteful way, the patches of forest left for their use, and now they are compelled, if they wish to obtain free forest produce, to clear the very boundaries that their forefathers insisted on having demarcated.

Their lands and villages are under the Revenue Department, but they themselves would willingly become forest villagers to avoid having to serve two masters, but there are no funds from which to pay the 20 years' purchase that the Revenue authorities would demand.

It is commonly believed that the diffidence displayed by even the jungly Jats in Assam as regards becoming forest villagers is due to fear that they will not be well treated: this is not the case and there is no reason to suppose that the exactions of the forest subordinates are any more vexatious than those of the revenue subordinates; the Forest Department has, however, omitted to make any provision for that fixity of tenure essential to the agricultural industry. Nobody can be expected to sow if there is not every chance of himself or his children reaping and if there is a distinct possibility of a Pharaoh arising, who knew not Joseph.

Any increase in the extent of reserve forests in the plains can only be made where the population is already considerable and is certain to oppose strenuously all attempts to reduce the extent of the waste lands, in which the people can now play about: it is clearly useless for the department to embark on any programme of expansion in such places, unless we can be certain of our proposals being considered from something wider than the parochial point of view, and of the mere convenience of the few not being allowed to outweigh considerations of the general good. The remaining waste lands are already circumscribed, and it may be supposed that reservation proposals will not stand much pruning down by the Forest Settlement Officer, but in most places, where reservation is justifiable on general grounds, the interests of the ryots can be protected by permitting them to remove forest produce and graze their cattle under certain conditions. Assam is not sufficiently advanced to appreciate or control village forests, but the establishment of reserves, from which the ryots had the right either to buy in cash or earn by work the small produce necessary for their domestic requirements, should prove a boon to future generations, and largely answer the purpose of village forests. The granting of rights of the above nature would be free from the taint of pauperization, would be fair to the people and could be prevented from becoming too oppressive to the reserves.

Turning to the hills, we are confronted there with quite another problem, that connected with 'jhuming' or shifting cultivation, a

practice that is becoming more difficult to deal with and regulate in consequence of the increase in population of the hill tribes and the *disappearance* of the forests. Villages could not expand much so long as head-hunting was in vogue, and an extensive No Man's Land was usually left between the different villages and clans, but the enforcement of the Pax Britannica permits cultivation to be carried on at long distances from the parent villages without danger from hostile raids. The increase in population is compelling the villagers in many places to return to the same 'jhum' at shorter intervals than formerly, and deterioration of the soil can be noticed. The Angami Nagas were forced, by the circumstance that hostile neighbours denied them expansion, to adopt a system of terrace cultivation with irrigation, and there is no doubt that the properties of the soil can be retained in this way alone.

It is to be expected that a progressive diminution of their crops might, in the course of time, drive the other tribes to adopt similar methods of cultivation, but if erosion should set in, giving rise to floods in the plains below, it may become necessary to put pressure upon the 'jhumers' to renounce the shifting in favour of the terrace system. The hills of Assam have appeared to be so densely timbered and the chances of destruction of the forests have appeared so remote, that little attention has hitherto been paid to the subject of protection of the catchment areas.

The importance of the problem, however, cannot be exaggerated, and the effects of denudation would be seriously felt in a province cut up, as Assam is, by a large number of swift-flowing rivers, rising in steep and rugged hills and fed by a copious rainfall.

India, as well as the outside world, furnishes numerous instances of the disastrous effects of erosion and of the great difficulty of arresting it, once it has started. An example of what may be in store for us can be seen close by in the Dooars where the Bengal Dooars Railway and some tea-gardens have suffered from the vagaries of the rivers. The cause of the trouble there is the Nepali settler in Bhutan, who has skinned the face of the hills towards the plains. There is nothing now to hold up the

water after heavy rain, so that the rivers rise quickly in spate and are continually changing their courses to the discomfiture of the railway engineer and the planter. Land-slides appear to be common on the face of the hills and are plainly visible from below The Nepalis have already advanced eastwards into the portion of Bhutan that touches the Goalpara boundary, and it is said that they propose invading the hills along the Kamrup border. Considering the difficulty the E. B. Railway already has in keeping open the Amingaon line, the eastward advance of the Nepali cannot be viewed without apprehension. We have one "Pagla-diya" (mad river) in North Kamrup, as it is, and no one can want to see the much bigger Monas becoming any more "pagla" than it is sometimes now. It is said that the Central Government of Bhutan does not find these invaders very welcome and that the Nepal Durbar objects to its subjects migrating in this fashion, so the matter in this particular instance could probably be dealt with without much difficulty, but the dangers of erosion and denudation can only be finally and effectually averted by Government assuming some sort of control over the catchment areas of the rivers which rise in the Himalayas, and at the same time affording suitable protection to the catchment areas situated in Assam itself.

This is a matter that ought not to be shelved until the need for action actually arises, because precautions taken now would cost practically nothing, whereas reafforestation is an expensive and troublesome operation once erosion has commenced.

I have already said that the first consideration in the fulfilment of a scheme for conserving the country's resources is that of preventing waste by judicious reservation. The second consideration is obviously how best these forests may be managed, but this falls outside the purview of this article, which only aims at showing that, as a preliminary to progress, we need some enunciation of policy, which will put our goal before us, and show how we are to be helped to attain it, and I hope that I have made it clear that the times demand something more definite than a benevolently platitudinous statement that forests are to be maintained where it is expedient that forests should be maintained.

It only remains for us to consider what effects increased local representation is likely to have on forest policy.

Ordinarily speaking, the effects will probably be small, but danger may arise in Assam from one source. The absorption of the waste land by leases and reservation, and the destruction of the unreserved forests is going to bring the Assamese face to face with that sad universal fact that very few people in this wicked world can expect to get anything for nothing, and before accepting the inevitable they are likely to make a little noise about it, seeing that the enjoyment of free forest produce is a tradition of the country. An agitation for disforestment would be a cheap path to popularity for the local legislator, to whom, unless previously tutored, the provincial and imperial advantages of forests are not likely to be obvious, while consideration for future generations at the expense of the present can only be expected from the most altruistic of politicians. The same statement of policy, then, that is instructive to the Settlement and Forest Officer should also be explanatory and educative to others.

It is difficult in writing such an article as this to steer a middle course between the uselessness of saying too little and the folly of saying too much while, on the contrary, it is remarkably easy to get one's intentions misunderstood.

The long and short of it is that the Forest Department have had a hard struggle to get anything done at all in this province, and though those days are gone for ever and we are now getting the backing that was denied our predecessors, yet it is still possible for reservation to be hampered or wrecked, if our proposals have to go through the hands of anyone who is not competent to deal with them, be it from ignorance or from prejudice.

We are now spending a great deal of time in adding on to our reserves pieces which were formerly cut out from the original proposals by someone who thought that they looked too big on paper. We have been busy in re-reserving land, that was once ordered to be disforested, but was then found to be useless for any purpose except that of growing forests. A statement of forest policy would make such blunders impossible in the future.

SPIKE DISEASE IN SANDAL.

AN INTERESTING ISOLATED AREA AND ITS TREATMENT.

BY P. M. LUSHINGTON, I.F.S.

On the top of the Javadis, at an elevation of 2,800 feet, is one of the most interesting isolated Spiked Sandal areas that has as yet been discovered. Spike was noticed in this forest in June 1917 by Ranger M. Muthuswamy Ayyar and the first report was to the effect that five acres, containing about 20 spiked trees, were affected. Subsequently, the area was demarcated and surveyed, and found to be 11 acres containing 65 trees. The first report was to the effect that the disease was "one season old."

This area is one of considerable interest, because it is about 100 miles from the nearest known "Spiked" forest. To the South is the South Salem District which is full of Sandal which, as far as is known, is quite healthy. To the North lies the stretch of the Javadi Hills on which a cent. per cent. enumeration was carried out in 1915 when the entire hills were declared to be free of the disease. To the East is a deep valley and the Chengam Javadis; and to the West is a large cultivated plain containing only a few scattered Sandal and then the hills of Mysore and North Salem. These hills have got spike, but on the lower slopes there is but little Sandal and no spike. It is almost certain that there was no spike early in 1915 when the enumeration was made, as all the enumerators were on the look-out for the disease. Subsequent to that period, the coupes lying to the west have been worked and subjected to observation when the marking and felling took place. This then is an area which has been subjected to a sudden outbreak of the disease, which probably first made its appearance with the new flush of leaves in March or April 1916. The only facts which may lead to the suspicion that the disease is older in origin are: (1) that as many as 65 spiked trees have been found; (2) that 11 fully spiked trees and two dead trees were found; and (3) that some trees had the red bronzed leaves which are characteristic either of a severe attack or of a late stage in the disease. The

percentage of dead trees is certainly not beyond the normal for a healthy Sandal forest.

The area spiked lies just half a mile south of the village of Nellivasal, and is mostly in the Reserved Forest but partly in Unreserved Land. The forest is of the deciduous type mixed with a good deal of bamboo. Immediately to the North, the Reserved and Unreserved forest stretches about one-fourth mile and ends in cultivation. The Stock Map shows five to ten Sandal trees per acre for the Reserve and scattered Sandal for the Unreserve. In the East is Reserved forest, with the same stock for a quarter of a mile followed by half a mile of deep valley without Sandal. To the South is a long strip of two miles of similarly stocked Sandal forest with no Sandal on either side of the strip. To the West is some waste covered with a thin growth and scattered Sandal. These fields, which were cultivated some years back, adjoin the regular cultivation which is a quarter of a mile wide, and these are succeeded by the big Chembarai hill with semi-evergreen forest and a good deal of Sandal. Of the 11 acres attacked, about three-quarters are Reserved and one-quarter Unreserved, but the Unreserved portion contained 31 spiked trees as against 34 found in the Reserve.

It has previously been noticed that the first outbreak of Spike often occurs in an exposed position. In this instance, the forest in which the disease has appeared is well sheltered, being 70 feet below the top of the ridge. In this respect, it resembles the Madeswarangudi isolated area of North Salem. At the same time, Spike appears to have developed first at the south-west corner which is the most exposed portion of the forest.

The surrounding country was thoroughly explored by Mr. Hearsey in September 1917, and no Spike was found except one tree near Chembarai 1,200 yards away, and another tree just half a mile to the south-west of the spiked area. Both these cases are doubtful. The Chembarai tree was greatly damaged by the cyclone of November 1916, and put out bunches of narrow gold coloured leaves but this was an expiring effort. The tree died a month later and has been removed. The second tree, together

with five others, was badly scorched by fire. Two out of this group of six have died, three are likely to recover and have nothing about them resembling spike, and the supposed "Spiked" tree has a few tufts of normal leaves. It is likely to die from the shock of the fire as all its bark is peeling off.

Mr. Hearsey, judging from the dead trees and the bronze colour of the spike, is of opinion that the disease dates from 1915. He particularly mentions that there is no Lantana in the area, nor is there any for some miles. In the adjoining forests and fields he found no less than 35 species of trees, shrubs, plants and creepers exhibiting clustered leaves similar to spike in Sandal.

The forest attacked has evidently not been fired for some years, shows no excess of grazing, has a fairly rich soil and no defect can be found with the growth except an unusually large amount of Spiked *Zizyphus Oenoplia.*

Early in October, measures were commenced to endeavour to check the spread of the disease. All the Sandal, whether attacked or not, were removed within the 11-acre plot. Unfortunately, on account was kept of the number of seedlings, but 668 trees of three inches girth and above were removed.

The stocking of the attacked area was exceptionally heavy, amounting to 60 trees per acre, as against the five to ten trees per acre shown in the Working Plan. But the stock itself is very remarkable and may be detailed as follows :—

Girth.	Number.	Prevailing stock.
3"—5"	30	13 of 5".
6"—12"	278	58 of 7", 46 of 9" and 44 of 12".
13"—18"	186	38 of 13", 36 of 14", 32 of 17" and 31 of 18".
19"—24"	106	25 of 19", 21 of 21", 20 of 22", and 20 of 24".
25"—30"	47	12 of 25", 10 of 26", and 10 of 28".
31"—36"	10	3 of 32", and 3 of 33".
37"—42"	5	2 of 38".
48"	1	
	663	

What is remarkable is the very small number of saplings of 3"—5" girth, there being only six of 3" girth.

As a further precaution, all the *Zizyphus Oenoplia, Dodonaea Viscosa, Scutia indica* and *Cipadessa fruticosa*, shrubs and climbers most susceptible to similar disease, were removed. The area has been fenced and will be burnt as soon as the grass is sufficiently dry.

All healthy sandal and the barred species are being removed over a zone of a furlong all round the fence and the distance has been measured. This zone should amount to approximately 40 acres but it is hardly necessary to have it surveyed. It is marked out by a continuous line of stones. The work has not yet been completed but 1,057 trees have been dug out. In course of extraction not a single spiked tree has been observed. The smaller trees, which contain no heart-wood, will considerably add to the total and, seeing that the western portion is almost devoid of Sandal, the stocking of the forest area is likely to prove as heavy as that of the spiked area.

A rough idea of the value of Sandal forest may be obtained from the outturn of scented wood obtained from the 11 acres which have been cleared, and this may assist in valuing the damage caused by Spike. Admittedly, the forest has been felled when the trees are much too young but, in spite of this, the yield from 11 acres has been no less than 907 quarters or over one ton per acre, which at present rates is valued at over Rs. 1,700. As there are only five trees over 36″ girth, the age of the forests must be well under 60 years. This would therefore amount to a value of Rs. 28 per acre per annum.

The only clue that has been found so far as to the origin of the disease is the number of other species similarly attacked which form a chain to the plains forest. It is further to be observed that, by an examination of the root system, Mr. Hearsey found two healthy Sandal trees with ten living attachments on Spiked *Zizyphus Oenoplia* and numerous dead haustoria and scars on the attacked *Zizyphus.* It is also to be noticed that he found the Red Spider and *Monophlebus* in large quantities in these forests just as he has done in North Salem.

CHARCOAL BRIQUETTES.

Copy of a Report, dated 3rd May 1917, by Messrs. R. S. Pearson I.F.S., F.L.S., Forest Economist, and Puran Singh, F.C.S., Chemical Adviser, Forest Research Institute and College, Dehra Dun.

GENERAL.

A preliminary report was issued on experiments carried out by which charcoal briquettes were manufactured using a hundred pounds pressure. These experiments demonstrated that a greater pressure was necessary in order to make a strong briquette, which led to a special die being prepared to enable the hand Hydraulic Press available in the workshops to be utilized. The following report details the experiments carried out when using a pressure of upwards of 4 tons per square inch.

The special mould above referred to consists of three parts, *i.e.*, a jointed male die held together by bolts and nuts, and a female die of slightly conical shape, the whole made to size so as to exactly fit the hand Hydraulic Press.

FIRST SET OF EXPERIMENTS.

The first set of experiments were carried out with material composed of a very fine dust and small pieces of charcoal, obtained from the Divisional Forest Officer, Hazara.

The small fragments of charcoal and dust were moistened with a solution of *Bauhina retusa* gum of varying strengths, or with a mixture of loam, cowdung and chopped straw. Samples of briquettes were prepared with these different binding materials, a pressure of about four tons per square inch being applied, which reduced the bulk of the material by from 40 to 50 per cent.

A suggestion was made by the Divisional Forest Officer, Jhansi, that the binding for the charcoal might be done with the help of a solution made from *Korikan* (*Urginea indica*) bulbs. This was tried but the mucilage was found to have insufficient adhesive properties unless used in a very concentrated solution.

Another suggestion made was to bind the charcoal with clay, and this was tried but with negative results. Yet another suggestion was to bind the dust with a solution made from chopped prickly pear, but owing to fermentation setting up at once in the solution this also failed.

SOLUTIONS USED IN THE MANUFACTURE OF BRIQUETTES.

For the purpose of the former experiments, a basic solution of one part of gum and five parts of water by weight was employed. The above ingredients were mixed and allowed to stand for forty-eight hours until the gum had had time to swell, when it was kneaded into a homogeneous mass.

From the basic solution, which may be termed (A), the following weaker solutions were prepared :—

(B) 1 part of (A) and 1 part of water = 8·3 per cent. of gum.

(C) 1 part of (A) and 2 parts of water = 5·6 per cent. of gum.

(D) 1 part of (A) and 4 parts of water = 3·3 per cent. of gum.

The following samples of briquettes were made by moistening the charcoal, which had previously been reduced to a coarse powder, by adding varying percentages of the above solution :—

I. Solution (D). 10 lbs. of the charcoal dust were mixed with 4 lbs. of this solution, the amount required to bring the mixture to a proper condition for pressing.

II. Solution (C). 10 lbs. of the charcoal dust were mixed with 4 lbs. 6 oz. of this solution, the amount required to bring the mixture to a proper condition for pressing.

III. Solution (B). 10 lbs. of the charcoal dust were mixed with 2 lbs. 12 oz. of this solution, the amount required to bring the mixture to a proper condition for pressing.

MECHANICAL TESTS FOR STRENGTHS.

The briquettes so prepared were allowed to dry in the sun for a fortnight, and were then tested as to their strength to resist pressure by loading with weights. Briquettes made with

(D) solution withstood a pressure of 5·3 lbs. to the square inch, or 160 lbs. per briquette before any signs of cracking occurred. They were further tested by being repeatedly dropped on to the ground from a height of four feet to ascertain whether they would break; this resulted in only the edges of the briquettes being chipped off, and the briquettes had to be thrown with some force on to the ground before they actually broke into pieces. It was found that No. I briquettes broke more easily than No. II, while No. III were the strongest. In the preliminary experiments only solution (A) was tried, while in this set of experiments weaker solutions, namely (B), (C) and (D), were also utilized. From the above described tests, it is thought that solution (C) is the weakest permissible. The mechanical tests for breaking briquettes made with clay gave fairly satisfactory results, the briquettes being about equal in strength to those made with (D) solution.

TESTS FOR COMBUSTIBILITY.

A further experiment was carried out to ascertain the combustibility of these briquettes, by preparing a charcoal fire in a blast furnace; it was found that only a dull heat resulted, even when applying a strong blast, and that as soon as the blast was stopped they ceased to glow, while the resultant ash was of a brown colour and resembled baked earth. This ash could not be due merely to binding the charcoal with a gum solution and in order to ascertain the cause, a sample of the charcoal dust received from the Hazara district was analysed and found to consist of 40 per cent. of mineral matter mostly earth, while the average sample of charcoal showed 31 per cent. of ash. It is therefore evident that the defective burning of these briquettes was due to the heavy admixture of earthy matter which they contained, which fact was further corroborated by the behaviour of the briquettes made up of charcoal, loam, cowdung and straw, which refused to burn at all.

SECOND SET OF EXPERIMENTS.

The experiments, therefore, had to be repeated and, in this case, a fair sample of Chir charcoal in stock was utilized for the

purpose. The charcoal was ground into a coarse dust. This charcoal, being more porous than oak and other hardwood charcoals, absorbed a larger quantity of the gum solution; thus, 9 lbs. and 7 oz. of Chir charcoal required 8 lbs. and 9 oz. of (C) solution to produce a suitable mixture for pressing. The ash on combustion was found to be 2·6 per cent., as compared with 31 per cent. in the case of the Hazara charcoal, while the charcoal briquettes on being burnt in a blast furnace produced an excellent fire.

COST OF BINDING PER MAUND (82½ LBS.).

The cost of manufacturing briquettes of charcoal dust will depend on the quality of the charcoal, *i.e.* (i) Light and porous charcoal and (ii) Heavy and compact charcoal.

(*i*) *Cost of making briquettes with light and porous charcoal.*

In the case of the light and porous charcoal one maund of charcoal requires 75 lbs. of the gum solution (C), or 4·2 lbs. of the gum. Rs. 5 per maund is the retail price of *Bauhina retusa* gum in the Dehra Dun bazaar, while the wholesale rate is Rs. 4 per maund. Therefore the cost of the (C) solution required to prepare one maund of briquettes at the higher rate, namely, Rs. 5, amounts to Re. 0-4-2, to which must be added Re. 0-1-6 for roughly powdering the charcoal and other incidental handling charges, or a total of Re. 0-5-8 per maund, say, in round figures Re. 0-6-0.

(*ii*) *Cost of making briquettes with heavy and compact charcoal.*

The heavy charcoal required less of the solution to make the particles adhere, namely, about 37 lbs. per maund of the (C) solution, containing 2 lbs. of gum. The cost of preparation, therefore, works out as follows :—

	Rs.	a.	p.
Gum 2 lbs. per maund	0	2	0
Powdering, handling, etc.	0	1	6
Total cost per maund	0	3	6

N.B.—Were the gum collected or purchased wholesale, the above cost of production might be slightly shaded.

CONCLUSIONS.

From the above experiments it was ascertained that :—

(*i*) Fairly strong briquettes can be produced by mixing the charcoal dust with a (C) solution of *Bauhinia retusa*, under a pressure of about four tons to the square inch, and that a hundred pounds pressure is insufficient (*vide* preliminary experiments) Whether an increase of pressure above four tons per square inch would give better consolidation of the charcoal briquettes cannot be ascertained with the machinery available.

(*ii*) Provided the charcoal dust is not mixed with earth, the resultant briquettes burn freely.

(*iii*) The quantity of binding material required in the case of porous charcoal, *e.g.*, that from Chir Pine, is greater than is the case for charcoal prepared from hard-wood species such as oak.

(*iv*) The briquettes dry slowly. Even after having been dried for two weeks in the sun, they were found, on being broken open, to be still moist in the centre.

(*v*) The cost of manufacture varies between Re. 0-3-6 to Re. 0-5-8, according to the class of charcoal employed.

(*vi*) The gum used in preparing the mucilage was obtained from *Bauhina retusa*, but probably any other cheap gum, which lends itself to being made up into mucilage, would answer the purpose equally well.

(*vii*) With *Bauhina retusa*, it was found that a fresh solution of gum should be made up every two or three days, as the mucilage on being kept deteriorated in quality and strength, owing to fermentation.

(*viii*) That the best method of mixing the basic solution is by means of a rotating wheel fixed in a wooden half barrel.

(*ix*) That the finer the charcoal is ground, the stronger are the briquettes.

This report on the experiments cannot be considered as final, as it will be necessary to carry out further experiments with different classes of charcoal.

ARBORICULTURE.

III. Tending of Avenues.

BY F. TRAFFORD, I.F.S.

[*Part I appeared in May* 1916 *and Part II in Nov.-Dec.* 1916.]

To the man in the street the ideal avenue is a high leafy tunnel under which passes a roadway or carriage drive. From an aesthetic point of view, nothing can be finer in appearance than a double line of lofty trees, with heavy branches arching overhead.

The main drawback of high branches over an avenue is that rain drops, falling from a height of fifty or sixty feet, with considerable momentum repeatedly on the same spot, wash out the binding material of the macadamized surface of the road: the wheels of carts coming along pick the loosened metal and the surface gives way.

Where there is unsuitable land, with a comparatively shallow surface layer of soil in a dry climate, a tree with too large a crown is apt to develop stag-headedness and die. In such places, any measures taken to keep down the crown, such as heavy pruning and pollarding, will give a tree which shows signs of stag-headedness a new lease of life.

Big branchy trees which offer a large surface to the wind are also more apt to be blown down than trees the foliage of which has been kept down by judicious pruning.

Avenues of big trees have their drawbacks where they occur in a civil station, particularly when they happen to grow close together. There is some justification for complaints that such trees interfere with the breezes so sought after in a hot climate. The energetic official who plants trees thickly along the road-sides probably does not realize the space they will occupy long after he has left the station. Cases have been known in cantonments of

the doctor prevailing on the commanding officer to go to the other extreme and have all trees cut down wholesale, thus letting in too much sun into the town of Dustypoor. Such cases would have been better dealt with by having a fairly heavy lopping made all round, thinning out such trees as are obviously too closely planted.

From a purely forest point of view pruning and pollarding are more likely to be injurious than beneficial to the forest crop, but avenue trees are not ordinarily grown to provide timber. They may provide fruit or supplement the fuel supply of the poorer parts of the community, but their main object is to provide shade. Unsoundness and hollowness of the stem are unobjectionable in an otherwise healthy avenue tree. The writer has dined inside the large hollow trunk of a Chinar in Kashmir on a memorably rainy night—the kitchen being set up in similar hollow tree adjoining; both trees were in splendid foliage.

Plane trees on the continent, especially in Switzerland, are trained in such a way that their branches appear to interlock and form a comparatively flat platform. This provides dense shade, under which chairs and tables are laid out while, at the same time, the outlook on the scenery from the upper windows of adjoining houses is in no way impeded.

The writer has seen banyan trees which, for some cause or another, have become flat-topped, which yielded the maximum of shade with practically no interference with the breeze.

Where good avenues of large healthy trees exist, it is unnecessary to interfere with them. If, however, any individual trees show signs of stag-headedness, especially after a year of short rainfall, it would be sound to give them a heavy lopping avoiding, however, the removal of lateral branches or branches more than four inches in diameter. Such branches as are lopped should be cut, either at a considerable distance from their junction with the trunk (or bigger branch), or else flush with the same. In the former case, the lopped branch will throw out new shoots and, in the latter, the bark of the trunk or branch will occlude over the wound. Short stumps sticking out are likely to rot and create unsoundness below their point of junction, besides being unsightly.

Where possible, it is better to start flattening out the crowns of trees at an earlier stage. This can be done when the main stem is about twenty feet from the ground. The process, however should be gradual, and if the crown is restricted so as not to exceed forty feet, the tree will be forced to grow out laterally and will then shade the road at no great height above the ground.

The system has not been tried but it would certainly work well with trees of the fig family, and probably with most shade trees which normally throw out strong lateral branches. Some of the *Albizzias* and trees like the Poplar, the branches of which do not spread, can hardly be expected to form good shade trees under any treatment.

PAPER-MAKING FROM *DAPHNE CANNABINA* (WALL.) IN GARHWAL, U. P.

BY *MATHURA PRASAD BHOLA, P.F.S.*

This shrub, locally known as Satpura, grows in the Garhwal District at an elevation of above 4,000 feet, as an under-growth in Banj (*Quercus incana*) and Tilonj (*Quercus dilatata*) forests. In certain parts of the district it grows in abundance, and there the people make paper out of its inner fibrous bark.

After the bark has been peeled from the stem, it is dried in the sun and then placed in water, after which it is well rubbed with the hand to separate the epidermis from the inner fibrous part. The latter is then placed in a basin containing a mixture of water and ashes (this for bleaching), and is boiled till it becomes soft and of a thick consistency, after which it is taken out of the basin and washed in clean water to free it from the ashes. The material so obtained is further pounded with wooden mallets to reduce it to a soft uniform mass. It is then made into balls, the size of the balls depending on the size and thickness of the paper to be made. This ball constitutes the refined pulp ready for conversion into paper.

The ball of pulp is put in a cloth sieve with a wooden frame, generally $2\frac{1}{2}' \times 1\frac{1}{2}'$—the size adopted for paper here. The sieve

with the ball in it is placed on water and the ball stirred by hand so as to make it spread out evenly in the frame, after which the frame is raised to allow the water to trickle out after which the frame is placed in the sun. It takes about one to two days for the paper to dry, when it is taken out and is ready for use.

The paper so manufactured, though a little loose in texture, is considered more durable than mill-made paper, and it is on account of this quality that important vernacular records, especially those connected with the revenue settlement, are maintained on this paper in the Garhwal District. The colour of the paper is pale grey.

If this antiquated method of manufacturing paper could be made labour-saving and improved upon by the use of simple mechanical means, it would be likely to prove a very useful cottage industry in Garhwal, and would afford profitable employment to the people in famine times. With the present method, a man can turn out daily on an average two sheets of paper which is sold at six pies per sheet.

By the production of paper of better quality at a lesser cost, the people will use the locally manufactured paper in preference to that imported into the district from the plains at a very high cost.

Any suggestions for improving this industry will be gratefully accepted.

GUIANA GREENHEART.

BY T. SINGTON, MANCHESTER.

The northern coast of South America and its hinterland form an area of vast extent covered, to a large degree, by dense forest with a wide variety of lumber, of which greenheart is an important constituent. The country enjoys a splendid tropical climate, it is well watered, and has several rivers of considerable size ; it is, therefore, an ideal one for development of tree-growth. The total area may be taken at 400,000 square miles, portion forming the Republic of Venezuela and other parts are Colonies of Great Britain, France and the Netherlands. There is an enormous sea-board, and a

depth inland of hundreds of miles; the main rivers are the Orinoco, Demerara, the Essequebo, the Corentyne, the Berbice and others, and a network of tributary streams. The larger rivers are navigable for a considerable distance, until rapids and falls make further progress impossible. The coast is generally low.

This article is limited to that section of the country which forms a British Colony and deals essentially with greenheart; it is the only lumber, which has been commercially dealt with to any extent hitherto. This British Colony has an area considerably greater than that of England and Scotland combined, and has a coast-line of no less than 270 miles; it extends southwards from the coast for distances ranging from 300 to 540 miles. All the rivers mentioned above, except the Orinoco, flow through it. On a tributary river there is a marvellous waterfall, with a sheer drop over a precipice of 750 feet; the actual drop including rapids is 900 feet. The width varies with the season from 250 to 350 feet. The lumber growth has so far only been very slightly tapped, as only the most accessible areas containing greenheart, wallaba, crab-wood and a few other species of lumber have been exploited. So far the demand for export has been limited to these varieties. Greenheart is, however, the essential export up to date and is the second most important export of the colony, the first being sugar. This lumber owes its importance to its important qualities of strength under all strains, and has been extensively used for ship-building during the last 150 years. Soon after becoming known, it was included in Lloyd's list of eight first class ship-building timbers. It is specially adapted for ship-building, as its essential feature is durability when kept immersed in sea-water. The introduction of iron for ship-building during recent decades has largely limited its use to engineering works for maritime purposes in harbours. An important characteristic of greenheart is its resistance to the attacks of sea-worms; another is its freedom from decay due, to a large extent, to the presence of an alkaloid, known as biberine; also, to some extent, to the lumber containing resinous substances scientifically named tyloses. In addition to the lumber, the bark and the seeds have commercial values, and are exported in quantity,

The tyloses, in the course of their growth in the cavities of the lumber, become dark in colour, colouring the surrounding lumber until it may be nearly black in colour. It is the extent of the tyloses development, together with the age of the tree which to a considerable extent, determines the colour of the lumber and causes the somewhat varied yellow, gray or black. It follows that the darker the colour, the older is the tree and the more durable the lumber.

The botanical name of the tree is *Nectandra Rodiæi*, Natural Order *Laurinæ*. The natives have several names for it :—Bebeeru, bibiru, supeira and sipiri.

European inhabitants call it torch-wood, owing to the fact that the heart-wood of the older trees, being filled with oil, burns very readily. Varieties of this lumber are said to grow in other South American areas, also in some of the West Indian islands, but it has been ascertained, that the trees found elsewhere are varieties, which do not possess the essential qualities of the greenhearts specified above, more especially the resistance to the attacks of sea-worms. It is important for consumers to know, that these inferior varieties also occur in Guiana; thus white 'ciroballi,' or 'siruaballi,' *Nectandra Surinamensis*, the yellow variety, occasionally known as black cedar, as well as the 'keritee,' or 'kretti,' grow side by side with the genuine greenheart. Only experts can, on occasion, distinguish between the useful and the inferior lumber varieties, as they closely resemble each other; but the latter are totally inferior in durability. A useful distinction is the weight test, the inferior varieties weighing 32 lbs. to the cubic foot and the real greenheart from 52 lbs. to 75 lbs. A tree growing in the island of Cuba is called greenheart, but belongs to a different genus. Other trees which have been substituted for greenheart occur in Jamaica and elsewhere in northern South America, but the real greenheart comes from Guiana. Trees in Guiana attain a great size, the conditions being very favourable, the heat being tropical and the rainfall plentiful. The height varies from 60 to 100 feet and more, whilst the diameter ranges from two to more than four feet. The trunks are branchless for a fourth, or third

of their height and generally have clean symmetrical trunks for about 50 or 60 feet. As the bole is not buttressed and as there are no branches for a considerable height, very long, clean squares can be obtained, admirably suited for engineering purposes. The greenhearts are of evergreen growth, but have more leaves during the wet season than during the dry. These trees grow very slowly, which probably accounts for their useful properties; thus specimens which have been authentically known to be seventy years old have been found to have only attained a diameter of eight inches. It may reasonably be assumed, therefore, that trees of about twenty inches diameter must approximate to an age of 250 years. The trees are stated to be reasonably abundant but they are not found more than 100 miles inland, the coast areas having conditions more suitable for their growth. They do not occur at any great height above sea-level and, rarely, on clay soil. Hill-sides are unsuitable, consequently where the country rises into hills there are no greenhearts, nor do they occur on rocky areas. Water carriage from the forest to the nearest harbour is the most economical for lumber; but greenheart has the disadvantage, that it will not float. In many countries such as the Black Forest district of Southern Germany, lumber is floated down the mountain torrents into the smaller rivers and then down the mighty Rhine from the south of Germany to Holland. For greenheart other measures are necessary; those at present applied are rather crude. Occasionally, steam winches are used for haulage; but, generally, oxen and a considerable number of native labourers are employed to transport the lumber. In some cases, good logging roads have been constructed; there is at present only one company working on a large scale. In due course more capital will be laid out in the construction of roads extending into the interior areas where the trees grow in quantity. A twenty-mile railway has been constructed from a point on Essequebo river to another on the Demerara river, where the lumber is loaded on to vessels for transport to Georgetown, a distance of 75 miles. From that port, the greenheart is sent to the different markets of the world. The wood is of slightly coarse open cane-like appearance, straight in

the grain and of hard texture. The sap-wood can hardly be distinguished from the heart-wood, and is not of great extent; it is as durable as the heart-wood. The specific gravity is 1,149; the transverse strain of 2" × 2" × 72" between bearings is 11,333 lbs. and the tensile strain on pieces 2" × 2" × 30" is 8,820 lbs. per square. The logs sometimes extend to a length of 60 feet; the squares may average 16 inches.

BAMBUSA ARUNDINACEA GROWING EPIPHYTICALLY AND EARLY FLOWERING OF SANDAL-WOOD TREES.

We have received two photographs (which are, however, unfortunately not clear enough for reproduction) from Mr. K. Govinda Menon, Conservator of Forests in the Cochin State.

One represents a clump of *Bambusa arundinacea* growing epiphytically on a tree—*Cassia Fistula*, the lowest point of attachment of the bamboo being 4'-3" from the ground.

The second photo is of a young sandal plant 14 months old, height 4'-5½", bearing flowers which are said to be quite normal in all their parts.

The writer would be glad to know if Forest Officers have observed similar phenomena elsewhere.

HON. EDITOR.

EXTRACTS.

BALSA WOOD (*OCHROMA LAGOPUS*).

We wrote at some length of the properties of this timber in our* issue of 10th February 1917 and return to the subject in order to furnish more details of this remarkable timber, as furnished by Mr. R. C. Carpenter and published in the number for May 1916 of the Proceedings of the American Society of Civil Engineers. It is evidently attracting some attention in America, more particularly since the construction of the Panama Canal in which region it grows freely; and though so far no special economic use has

* Published in *Indian Forester* for May 1917, page 241.

been found for it on anything like a large scale it seems certain that the remarkable properties of the timber will bring it into prominence before long.

The structure of the wood is altogether special; it is composed of very thin-walled cells of barrel shape which interlace with each other and contain scarcely any woody fibre; these cells are filled with air and hence are derived both the extreme lightness of the wood and its property of non-conductivity of heat. Its weight when thoroughly dried is 7·3 lbs. per cubic foot, cork which stands next in lightness weighing 13·7 lbs. per cubic foot. It is not easily obtained in a dry condition, however, and therefore as obtained commercially it will be found to weigh from 8 to 13 lbs. And though so light it has remarkable strength comparatively, and great elasticity. The cells which are parallel to the axis of the tree are made up principally of woody fibre, those which extend in a radial direction usually have a cellulose structure with little woody fibre, and are defined as "medullary rays" or pith cells. The annual concentric rings show very feebly. The difference between balsa wood and cork lies in the circumstance that the first has interlacing fibres around the cellular structure, the latter has none but the place of the fibres is taken by a resinous deposit which gives it no structural strength. This resinous deposit can be collected by means of pressure and heat to make what is known as cork board which is put on the market in blocks 2 or 3 inches thick and from 2 to 6 feet long, convenient for use as a lining in cold storage or other structures.

Professor Carpenter has made some tests of the wood which showed its compressive strength to average 2,225 lbs. per square inch; and Professor Leland, who has also made tests with much the same results, writes—"The crushing strength seems to be very satisfactory for such wood—about one-half the strength of white pine or spruce. These tests show the modulus of rupture to be approximately one-half that of good spruce, and their uniformity clearly shows that the material may be relied upon both for direct compression and transverse loads. It is very elastic material, and when the load was almost at the breaking point the load on three

of the beams was removed and the beams resumed their original shape. It is exceedingly interesting to note that it is practically impossible to split the wood by driving nails through it." A plank of balsa wood 10 feet 8 inches between supports, 5½ inches wide and 1¾ inches thick, supported two men who together weigh 387 lbs. The maximum deflection at the centre was about ten inches. The tree grows freely in all Central American States and in the northern parts of South America as a second growth tree. About the Isthmus of Panama it has sprung up in all the cleared spaces not under cultivation; it is a rapid grower, attaining a diameter of 12 to 14 inches at an age of 4 or 5 years by which time it may be from 40 to 60 feet high. The leaves vary in length from 14 to 30 inches. It is said never to be found in the virgin forest except as an isolated tree or two where clearing has occurred, but to spread freely in its habitat as a second growth. Its seed pods yield a woolly fibre suitable for pillows and mattresses we presume somewhat similar to those of the cotton trees or *simal*, and the natives often cut down the tree solely for its pods.

Experiments show moreover that heat transmission through balsa wood though not much higher than through cork is considerably lower than through white pine and very considerably lower than through zinc.

In our issue of 10th February 1917, we mentioned certain properties of the wood and certain uses it might be put to, and these points need not be brought forward again. But from the additional facts mentioned now we might conclude that further uses of the wood may be as planks for scaffolding and as packing cases, tea boxes in particular. Being a fast-growing tree it could easily be introduced into Indian forests and being light and easily handled its cost should be low.—[*Indian Engineering.*]

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A PRELIMINARY NOTE ON THE MANUFACTURE OF WOOD-TAR.

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER, FOREST RESEARCH INSTITUTE.

Introduction.

Wood-tar is one of the products of the dry distillation of wood, and is divided for market purposes into Wood-tar or broad leaf and Stockholm or pine tar. The manufacture of Stockholm or pine tar is a well-established industry in Sweden, where "fat" or highly resinous wood is carbonized in kilns and the tar recovered, while all other products are neglected. Large quantities of Stockholm tar were annually imported into Calcutta before the War, as it is required in large quantities in jute mills for tarring ropes. Owing to foreign supplies of this article having been practically cut off, it has been suggested that a remunerative industry could be developed in the pine forests of India in order to meet the requirement of the jute mills of Calcutta. Experiments had, however, already been initiated by Mr. Canning in the Kumaun Circle with a view to utilizing twisted 'Chir' (*Pinus longifolia*) wood for this purpose and, at his request, similar experiments were carried out at the

Forest Research Institute, while the Punjab and Bengal Forest Officers are also considering the question of starting this industry.

Stockholm tar and its constants.

"Stockholm tar" is essentially a very cheap varnish, consisting of resin, turpentine and tarry oils. When allowed to settle, it deposits a granular crystalline matter consisting mainly of pyrocatechol. The British Pharmacopœia lays down the following characters and tests for Stockholm tar, officially termed *Pix Liquida :* "Dark brown or nearly black; semi-liquid; empyreumatic odour; heavier than water. Water shaken with it acquires a pale brown colour, sharp empyreumatic taste and acid reaction; very dilute T. Sol. of Ferric Chloride colours the solution red. Tar is completely soluble in ten times its volume of alcohol."

The following table gives the results of the comparative analysis of four samples of tar, two made by Mr. Canning and the writer by distilling the wood in retorts; a third prepared by Mr. Mathura Prasad Bhola, Divisional Forest Officer, Southern Garhwal Division, in a modified retort, and a fourth, Stockholm tar imported into Calcutta and received from Messrs. Bathgate & Co., Calcutta:—

	1 * Tar dried at 105°C. before analysis; received from Mr. F. Canning.	2 Retort tar made at Dehra Dun Forest Research Institute.	3 * Tar received from Mr. Mathura Prasad Bhola. Dried at 105°C. before analysis.	4 Stockholm tar as imported.
Colour ...	Very dark brown.	Very dark brown.	Very dark brown	Dark brown.
Odour ...	Empyreutic, smoky.	Empyreutic, smoky.	Empyreutic, smoky.	Empyreutic, smoky.
Reaction ...	Acid ...	Acid ...	Acid ...	Acid.
Consistency ...	Semi-solid ...	Thick syrupy	Semi-solid ...	Semi-solid.
Solubility in 90% alcohol.	Completely miscible.	Completely miscible.	Completely miscible.	Completely miscible.
Specific gravity...	1·054 ...	1·066 ...	1·091 ...	1·073
Light oil (up to 250°C.)	18·93 % ...	29·2 % ...	16·62 % ...	30·6 %
Heavy oil (up to 340°C.)	46·15 % ...	41·1 % ...	42·11 % ...	44·4 %
Pitch (black and brittle).	34·92 % ...	23·9 % ...	28·77 % ...	23·6 %

* These tars Nos. 1 and 2 had 20·1 and 12·50 per cent. of moisture and pyroligneous acid, respectively, as compared with 1·4 per cent. of the imported article.

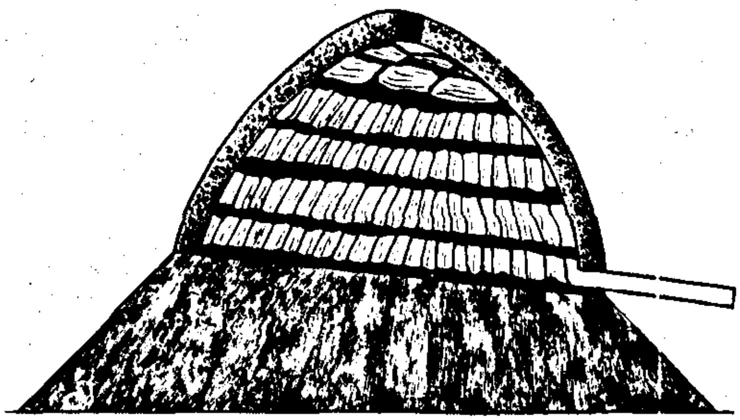


FIG (a)

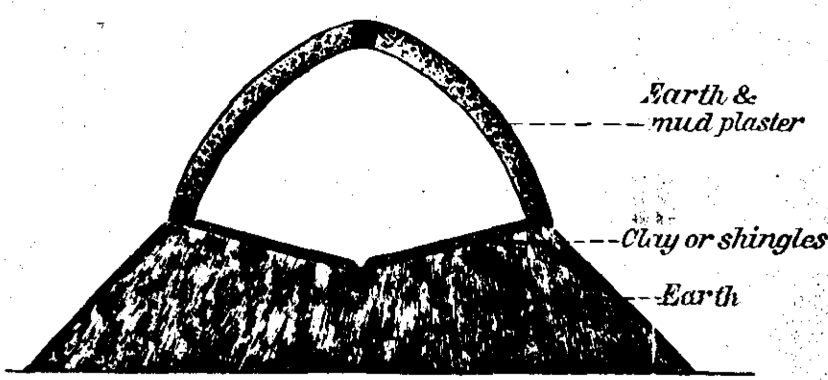


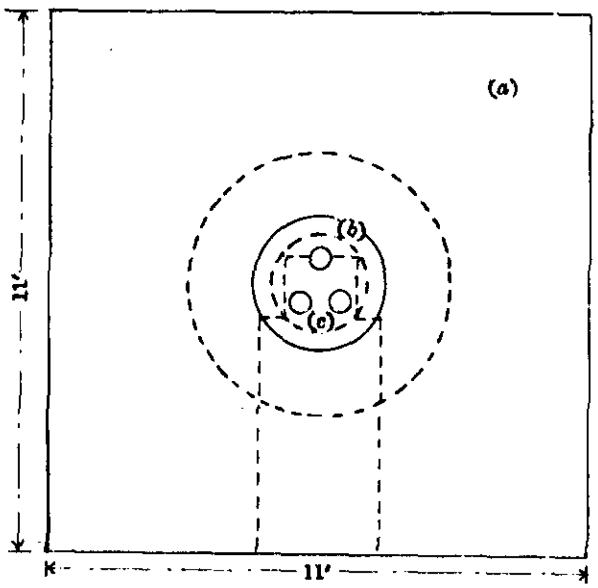
FIG (b)

Photo-Mechl. Dep., Thomason College, Roorkee.

TAR KILN

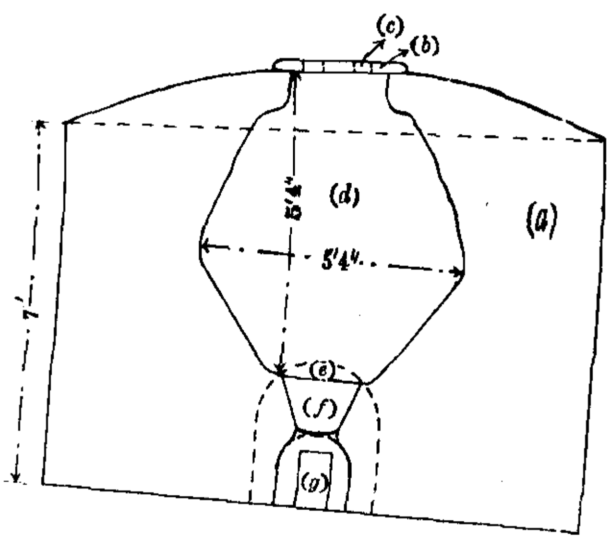
EXPERIMENTAL KILN FOR PRODUCTION
OF CHIR TAR
ERECTED AT UKHALLEKH WEST ALMORA DIVISION.

Scale—1 Inch = 4 Feet.



PLAN.

(a) Stone and Lime Mortar Masonry
(b) Stone Lid
(c) Draught Holes
(d) Chamber for Wood
(e) Fire Bars
(f) Strainer
(g) Collecting Tin



SECTIONAL ELEVATION.

Photo Zinco, March, 1918. No. 2049-I-8C.

Manufacture of Stockholm tar by Kiln process.

As already mentioned, "Stockholm" tar is generally made in Sweden, Russia and other places, by burning highly resinous wood in various forms of kilns with special bottoms to drain off the tar from the wood which is being carbonized. The wood is cut into small pieces and is stacked in layers as shown in Plate 5, Fig. (a). As the wood burns and heat is developed in the kiln, the tar runs to the bottom and drains down the slopes of the V-shaped trough at the bottom of the kiln, shown in Fig. (b).* In these kilns, the bottom is covered with shingles in order to get clean tar, free from dirt and dust. The fire is lighted at the bottom and the vapours escape at the top, as the fire progresses from the sides to the middle of the kiln. It is stated that it generally takes many days before the tar commences to run, and considerable quantities of charcoal are burnt up in the process. It is thus evident that the kiln process is only suitable for the treatment of very "fat" pine woods; and even then the yield of tar is much less than when the wood is treated in closed retorts on account of the combustion of a portion of the tar itself in the kiln. This point has been further confirmed by the experiments carried out in the field by Mr. F. Canning and also by the writer at the Forest Research Institute. Mr. Canning made a kiln of the type sketched in Plate 6, which yielded no tar. The writer employed a vertical double-walled kiln in which the draught was properly regulated, with negative results, only crude pyroligneous acid being collected. The kiln made on the Swedish model with a galvanized iron sheet bottom was also tried without success. The reason for this is, no doubt, that the wood used had only 5·72 per cent. of tar as determined by distilling it in a copper flask in the laboratory.

It seems almost impossible to convert "lean" wood into tar by the kiln process, though there is no doubt that a portion of the tar is recoverable by this process from "fat" wood. The chief merits of the kiln process are that large quantities of wood can be treated without much initial outlay on plant, while it does

* Both figures (a) and (b) are taken from the "Utilization of Wood Waste by Distillation," by W. B. Harper.

not involve transport of machinery from place to place as the fellings advance through the forest; the disadvantages in the process consist in the loss of most of the charcoal while recovering the tar, and in the loss of tar itself when dealing with "lean" wood.

The Retort process.

The Retort process is simple and very easy to carry out. The still used at the Forest Research Institute and with which the experiments detailed below were carried out, is shown in Plate 7. It consists of a still made of ordinary thick iron sheets (though for commercial purposes, the still should be made of thick cast-iron such as is generally used in the dry distillation of wood and oil) with a trap-still between it and the condenser, the still being surrounded by a furnace, provided with a chimney.

The process of operating the still is as follows:—

The still is charged with split billets and gradually heated up to dull red heat; as distillation proceeds, the tar fumes are condensed in the trap-still and the pyroligneous acid's vapours pass on and are condensed in the condenser shown in the sketch. As tar should be free from moisture and pyroligneous acid, it is advisable to catch the tar in such a trap whatever be the form of the still employed. Tar was prepared in a plant admittedly by no means perfect by the writer at the Forest Research Institute and, when taken out of the trap-still, was packed direct for commercial valuation without any further treatment. The Forest Economist, who sent the sample to a Calcutta jute firm, obtained the following report which is highly encouraging:—

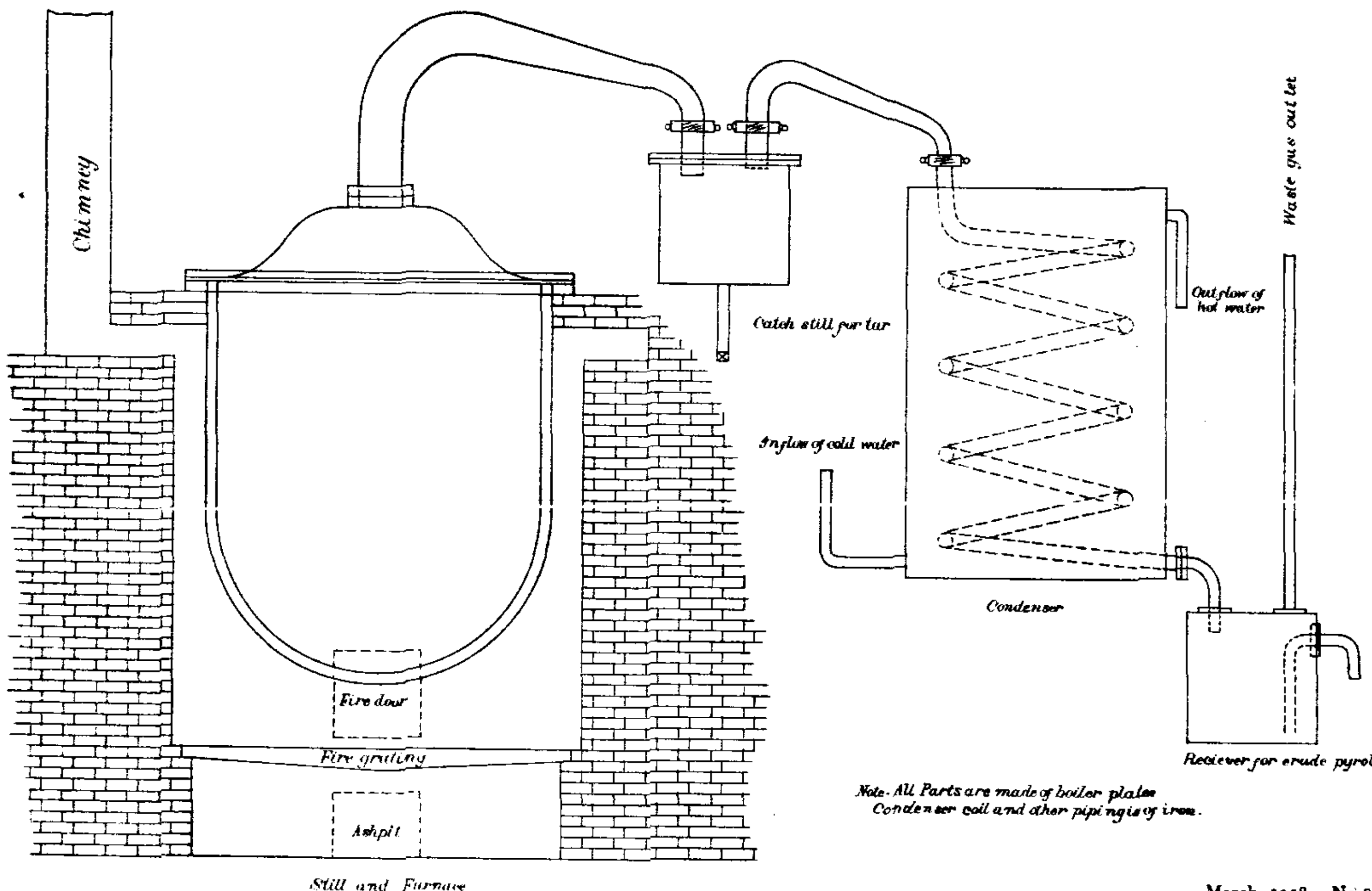
"Our Mill Department are quite certain this tar will suit our purpose."

Mr. F. Canning's experiments.

The retort used by Mr. F. Canning is sketched in Plate 8. The tar obtained in this retort is of standard constants and consistency except that it has an excess of moisture and pyroligneous acid, which, as stated above, can be obviated by working with a delivery pipe fitted on the top of the retort and by leading the tar vapours into a trap-still.

WOOD TAR STILL

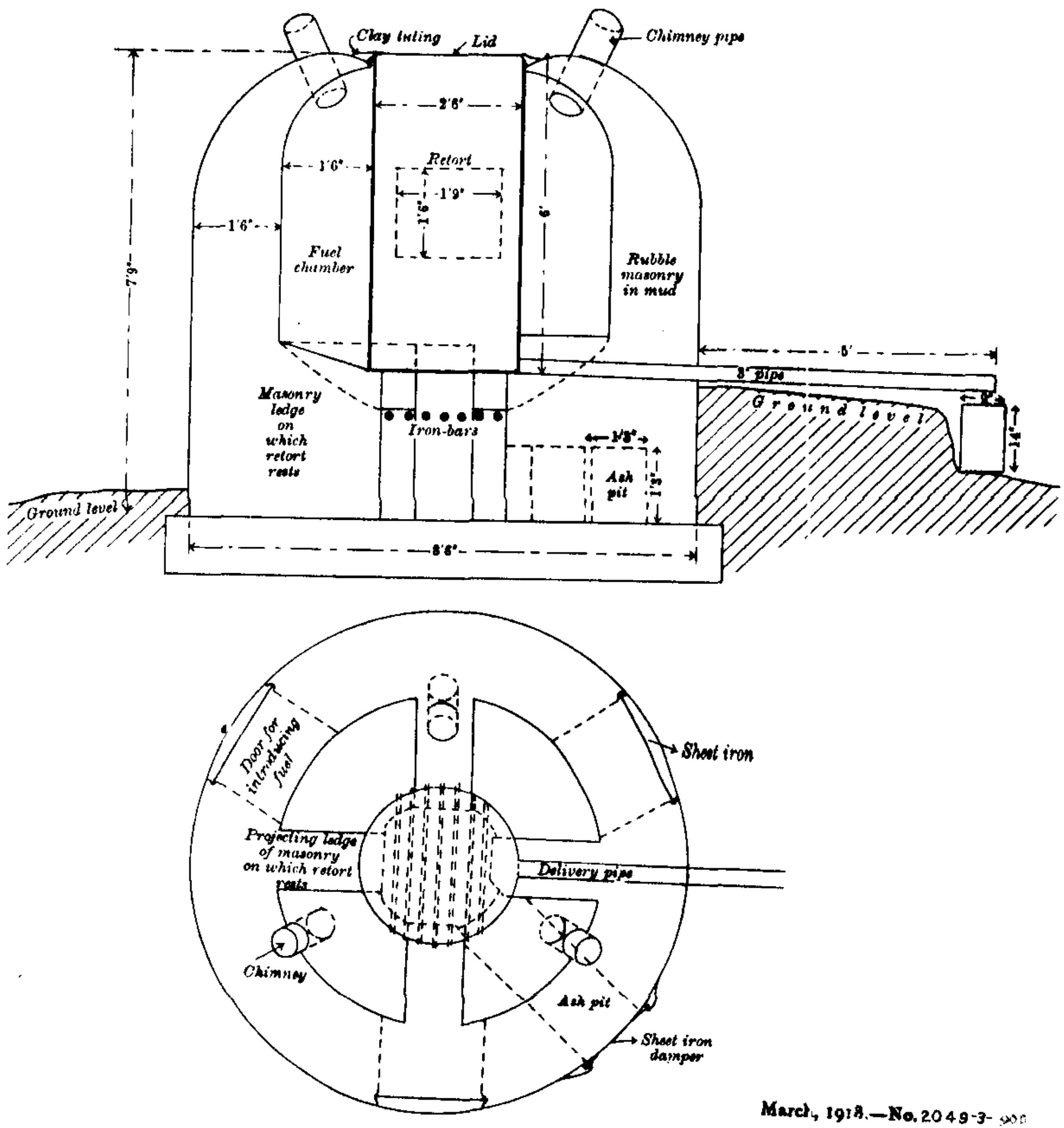
Scale 1/16 Full Size



Note. All Parts are made of boiler plates
Condenser coil and other piping is of iron.

PLANT FOR MANUFACTURE OF CHIR TAR
AT
KHAJURI, WEST ALMORA DIVISION.

Scale—1 Inch = 3 Feet.



March, 1918.—No. 2049-3-900

The yield.

It is difficult to give any figures of yield, as they depend on the quality of the wood employed for the purpose. As stated by Allen in his Commercial Organic Analysis, the yield is 7·10 per cent. of the wood, while from analysis of the Chir wood, which was afterwards treated in retorts at the Forest Research Institute by the writer, the yield of tar was 5·72 per cent on the weight of the wood. On the other hand, Mr. Canning, in one of his experiments, when treating very resinous wood, obtained as much as about 25 per cent.

Yield from Chir wood from Kangra.

Mr. Walters, Working Plan Officer, Kangra, submitted samples of twisted Chir wood which yielded the following percentages, when treated in the plant as shown on Plate 7:—

		Per cent.
The tar collected in the trap-still	...	6·77
Crude pyroligneous acid ...	...	25·13

Market rates for Stockholm tar.

As regards the market price of "Stockholm tar," a quotation dated 24th August 1917 is Rs. 125 per barrel of $2\frac{1}{2}$ to $3\frac{1}{2}$ cwt.

Oak wood tar.

In order to see whether the tar distilled from the Himalayan oak would serve the purpose for tarring ropes, a charge of oak wood received also from Kangra was distilled in the same plant, with the following results:—

		Per cent.
The tar collected in the trap-still	...	1·04
The tar recovered from the condensed liquids	...	1·00
Crude pyroligneous acid ...	...	21·6
Charcoal	...	26·2

The yield of tar is extremely low, and would in itself not justify distillation unless there was also a good demand for oak charcoal. Broad-leaf tar does not fetch the same price as Stockholm tar; on the other hand, the charcoal is far superior to that obtained from pine wood, especially when prepared in retorts, so that it will very likely be found profitable to prepare it in this way

and, at the same time, recover the tar. The tar, as obtained from the trap, was sent to Calcutta by the Forest Economist for valuation, and the report received states that it is quite as suitable for their purpose as the pine tar.

This indicates that any wood tar would be equally suitable for the purpose of tarring ropes, and a field for the utilization of such waste materials as saw-dust of teak and other broad-leaf woods is thus opened up.

Sal wood.

The Sal (*Shorea robasta*) wood obtained for fuel purposes from the Siwalik Division containing 11 per cent. of moisture was distilled and 27·6 per cent. of charcoal, 4·4 per cent. of tar and 31 per cent. of crude pyroligneous acid was obtained.

Wood of *Mallotus philippinensis.*

The wood of *Mallotus philippinensis* obtained from the Siwalik Division containing 48·02 per cent. of moisture was distilled and 20·45 per cent. of charcoal, 1·76 per cent. of tar and 35·45 per cent. of crude pyroligneous acid was obtained.

Wood of *Odina Wodier.*

The wood of *Odina Wodier* obtained from the Siwalik Division containing 59·14 per cent. of moisture gave 19·20 per cent. of charcoal, 1·17 per cent. of tar and 34·37 per cent. of crude pyroligneous acid.

In this connection, it may be of interest to give the results of analysis of a sample of wood-tar prepared by a crude retort-method (the retort being an earthen pot), from the wood of "*Erythroxylon monogynum*," kindly sent by the District Forest Officer, Kollegal District, Coimbatore:—

	Per cent.
Specific gravity at 27°C.	1·079
Moisture and pyroligneous acid ...	12·96
Light oil (up to 250°C.)	13·02
Heavy oil (up to 340°C.)	54·24
Pitch	19·78
Phenolic bodies	16·8

These results show that it is an excellent sample of wood tar in heavy oils. Its well-known medical properties, for which it is so

highly prized by the local people, are no doubt due to the high percentage of "phenols" that it contains.

Conclusions.

The conclusions arrived at from this enquiry may be briefly stated as follows :—

(1) That the tar obtained by distilling twisted "Chir" pine wood in retorts is of the same quality as the imported "Stockholm tar."

(2) The kiln process of manufacturing "Stockholm tar" is not suitable for distilling "lean" wood, while even when dealing with a rich resinous wood the yield is less from a kiln than from a retort.

(3) *If transport is difficult, then a battery of portable retorts* fitte[illegible] tar traps only is advocated. If, on the othe[illegible]d, moving the plant involves no great difficulty and if there is likely to be a sale for crude pyroligneous acid, the necessary condensers for catching the pyroligneous acids and leading the uncondensible gases back to the furnace may also be included.

(4) Should the conditions of distillation cause the tar traps to become very hot they must be kept cool by a wrapping of wet gunny bags or some such similar arrangement.

(5) The "Chir" charcoal, when not marketable in any quantity, may be used as fuel for heating the retorts.

METHOD OF WORKING BAMBOOS.

BY E. MARSDEN, I.F.S., SILVICULTURIST FOREST RESEARCH INSTITUTE, DEHRA DUN.

Experimental plots to ascertain the best system of working *Dendrocalamus strictus* bamboos were laid out by Mr. R. S. Troup in 1910, and have been examined in detail annually since.

The variations in method under experiment have been :—

(1) Rotation : (*a*) Cutting the bamboos annually.

(*b*) Do. do. every second year.

(*c*) Do. do. every third year.

(*d*) Do. do. every fourth year.

(2) Proportion of bamboos cut:

In the 1- and 2-year rotation clumps—

(*a*) Cutting all bamboos except the new shoots of the current year.

(*b*) Cutting half the bamboos except the new shoots of the current year.

(3) Height of cutting:

(*a*) Cutting the bamboos above the first node, *i.e.*, close to the ground.

(*b*) Cutting the bamboos above the third node.

(*c*) Do. do. do. fifth do.

Note.—In no clumps were new shoots of the previous rains cut.

Mr. Troup selected two localities in the United Provinces, the one dry and the other comparatively damp. Ranipur, in the Siwaliks Division, is the dry locality, and Kotdwara in Lansdowne Division, the damp locality.

At Ranipur 3 clumps, and at Kotdwara 5 clumps, not adjoining each other but distributed over the experimental plot, were subjected to each variation of the experiment.

Of recent years, the bamboos in these localities had been worked under a 3 years' rotation, all culms except the shoots of the current year being cut. Thus, at the time the experiment started no culms were more than two rains old.

Before beginning work in the experimental plots, all clumps were thinned of dead and imperfectly developed culms.

SUMMARY OF RESULTS.

Rotation—1 year.

At Ranipur. After 8 years, removing annually all culms except new shoots, out of 9 clumps 4 are dead and 5 are producing only switches. Difference in height of cutting has had no effect.

At Kotdwara. After 8 years, removing annually all culms except new shoots, out of 15 clumps 11 are dead, 2 have produced no shoots this year and are in hopeless condition, 2 are failing.

At Ranipur. After 8 years, removing annually half the number of culms except new shoots, out of 9 clumps 4 are producing only switches, 5 are in fair condition. Difference in height of cutting has had no effect. During the 8 years, the 5 clumps in fair condition now have produced per annum an average of—

5·3 culms, mean length 15·7 ft., centre-girth 2·1 inches.

At Kotdwara. After 8 years, removing annually half the number of culms except new shoots, out of 15 clumps 7 are in good condition, 8 are poor or bad. Difference in height of cutting has had no effect. During the 8 years, these 15 clumps have produced per annum an average of—

3·2 culms, mean length 19·7 ft., centre-girth 2·8 inches.

Rotation—2 years.

At Ranipur. After 8 years, removing every second year all culms except new shoots, out of 9 clumps 1 has flowered and died, 3 are dead from overworking, 1 is producing only switches, 1 is producing much shorter culms, 2 are producing shorter and thinner culms, 1 is in good condition. Difference in height of cutting has had no effect. During the 8 years, the 4 clumps still productive have yielded an average per annum of—

5·8 culms, mean length 20·0 ft., centre-girth 2·6 inches.

At Kotdwara. After 8 years, removing every second year all culms except new shoots, out of 15 clumps 2 have flowered and died, 4 are dead from overworking, 1 is in good condition, 8 are poor or bad. Difference in height of cutting has had no effect. During the 8 years, the 9 clumps still alive have produced an average per annum of—

2·4 culms, mean length 22·5 ft., centre-girth 2·7 inches.

At Ranipur. After 8 years, removing every second year half the number of culms except new shoots, out of 9 clumps 1 is dead and 1 is producing only switches, 3 are producing shorter culms but are otherwise in fair condition, 4 are in good condition. Difference in height of cutting has had no effect.

During the 8 years, the 7 clumps still productive have yielded an average per annum of—

3·6 culms, mean length 20·6 ft., centre-girth 2·5 inches.

At Kotdwara. After 8 years, removing every second year half the number of culms except new shoots, out of 14 clumps 1 has flowered and died, 10 are in good condition, 1 fair and 2 poor. Difference in height of cutting has had no effect. During the 8 years, the 13 clumps alive have produced an average per annum of—

2·6 culms, mean length 24·1 ft., centre-girth 3·0 inches.

Rotation—3 years.

At Ranipur. After 6 years, removing every third year all culms except new shoots, all 9 clumps are in good condition; they have produced an average per annum of—

Cutting at a height of—

3·8 culms, mean length 19·5 ft., centre-girth 2·7 inches...1 node.
4·9 culms, mean length 20·0 ft., centre-girth 2·7 inches...3 nodes.
5·4 culms, mean length 22·2 ft., centre-girth 2·9 inches...5 nodes.

At Kotdwara. After 6 years, removing every third year all culms except new shoots, out of 15 clumps 1 has flowered and died, 2 are dead from overworking, 3 are in good condition, 2 fair, and 7 poor or bad. Difference in height of cutting has had no effect. During the 6 years, the 12 clumps alive have produced an average per annum of—

2·4 culms, mean length 23·7 ft., centre-girth 3·1 inches.

Rotation—4 years.

At Ranipur. After 8 years, removing every fourth year all culms except new shoots, all clumps are in good condition; they have produced an average per annum of—

Cutting at a height of—

2·8 culms, mean length 21·0 ft., centre-girth 2·6 inches...1 node.
5·3 culms, mean length 20·0 ft., centre-girth 2·5 inches...3 nodes.
5·0 culms, mean length 20·0 ft., centre-girth 2·5 inches...5 nodes.

At Kotdwara.—After 8 years, removing every fourth year all culms except new shoots, out of 15 culms 2 have flowered and died, 6 are in good condition, 3 fair, and 4 poor. Difference in height of cutting has had no effect. During the 8 years, the 13 culms alive have produced an average per annum of—

3·2 culms, mean length 28·1 ft., centre-girth 3·1 inches.

FURTHER OBSERVATIONS.

Rate at which stumps of felled culms dry up.—It has been stated that the stumps of felled culms dry up at the rate of one internode a year. Repeated observations record that the topmost internode of the stump is dry generally after one year, but not always. In many cases, the rest of the stump remains green for 3 or more years. The rate at which the stump dies is irregular and may depend on the vigour of the clump, the treatment to which the clump has been subjected, and the season of cutting. In some cases, the whole stump remains green for years, and this is the case whether side-shoots have been sent out at the nodes or not; in some cases, the whole stump dries up in one year, and this is common in clumps severely overworked. It is rare for the whole stump to dry up gradually; when this occurs, the rate is very slow.

Effect of heavy rain upon production of new shoots.—The 1916 rains were heavier than usual, and the new shoots of this year were taller and thicker than those of the previous 6 years. More shoots were produced than usual, while some clumps which were almost dead revived and sent out new shoots. But the 1917 rains were still heavier, and the new shoots were only average in number and quality.

Vitality of culms.—It was observed at Kotdwara in November 1916 that the culms of 1909 were undoubtedly drying up, and those of 1910 too to some extent; culms of 1911 doubtful, some drying up, some still green; culms of 1912 all green. This suggests that here a rotation of more than 4 years might lead to some culms drying up before they are felled, causing a decrease in their value, and that a rotation of 6 years or more would be very risky.

Effect of cutting all culms including new shoots.—At Ranipur in December 1911 three clumps were clear-felled at a height of one foot from the ground. They contained :—

Old culms.	New shoots.	Length.	Centre-girth.
9	8	22′	2·7″
4	3	19′	2·5″
10	5	26′	2·9″

In December 1912, all 3 clumps were alive and had produced a number of bushy and some whip-like shoots. The bases of more than half the culms cut had dried up completely. In January 1915, the first clump had produced 8 whippy culms, the other two were quite dead.

At Kotdwara, in January 1913, three clumps were clear-felled. They contained :—

Old culms. New shoots.	Length.	Centre-girth.
18	25′	2·4″
9	32′	3·7″
22	37′	4·1″

In November 1913, the three clumps had produced 2, 1 and 3 slender new shoots in addition to a number of short switches.

In 1914 each clump had put out one more thin new shoot.

In 1916 the first clump contained two whip-like culms ¼″ thick ; the second clump contained three culms ¾″ thick ; and the third clump contained six culms up to ¾″ thick.

In 1917 the first clump was dead, the second had 3 old culms and one new, the third 6 old culms and one new, but all thin.

Clear-felling part of a clump has a tendency to kill that part of the clump.

Removal of all culms except new shoots causes the new shoots to bend over owing to lack of support.

Season of cutting.—If bamboos are cut in September and dragged out of the clump, the new shoots are often bent, because they are still soft. From this aspect it would appear desirable to defer cutting bamboos as late as practicable before the next rains

Among other points, the risk of danger from fire and the possibility of completing extraction during the open season would have to be considered.

Lignification.—New shoots lose their sappy softness and become hard certainly before they are 15 months old, and probably after 9 or 10 months. In January, culms 18 months old are very difficult to distinguish by eye from those 30 months old.

Flowering.—Clumps often flower partially. At Kotdwara, clump No. 91 flowered in 1912 but one thin new shoot appeared in 1913. All the old culms except one of 1912 flowered and died, but the new culm of 1913 is thriving. The same observation was made elsewhere in Paniali Block, old culms flowering and dying, while new shoots appear amongst them green and healthy.

Cutting culms below ground-level.—This has been stated to affect the vitality of the rhizomes and to produce congestion in the clump. Of five clumps treated thus on a 3-year rotation, one flowered, one died, and the other three are in poor condition after 8 years. This method seems bad.

CONCLUSION.

(It should be noted that these conclusions refer only to *Dendrocalamus strictus* in the United Provinces.)

1. Annual working, whether cutting high or cutting low, whether removing all old culms or only half of them, leads to more or less rapid reduction in size of clump, in number of new shoots, and in girth of culms.

2. When all the culms except those of the current year are cut, the clump deteriorates. This is true for 1-year, 2-year and 3-year rotations, and for cutting at a height of one node, three nodes, or five nodes. When the rotation is 4 years, this result is not so obvious.

3. When the rotation is one year and only half the number of old culms is cut, the results are better than when all old culms are cut. Height of cutting makes no difference. Of 15 clumps treated thus, only two were in good condition, and this method cannot be recommended. When only half the old culms were cut, the clumps

under a 2-year rotation were in much better condition than those under a year rotation.

4. Whatever the rotation, some old culms should be left. Old culms are wanted both for the mechanical support of new shoots and to maintain the rhizomes in full vigour.

5. The effect of difference in height of cutting upon the health of the clump is either *nil*, or so slight as to be negligible. Cutting high produces a number of twigs at the top of the stumps which impedes working.

Production of new shoots is not affected by height of cutting. But removing half the old culms gives more shoots than clear-felling all old culms, and 2-year rotation more than 1-year rotation. Of the methods under experiment, most new shoots were yielded by the clumps worked under a 2-year rotation when half the number of old culms were felled. Felling all the old culms fails to produce many new shoots even when the rotation is four years. But a 3-year rotation, some of the old culms being left standing, would probably give better results than a 2-year rotation.

Clear-felling all culms, including shoots of the current year nearly, but not quite, kills the clump. After four rains the clumps are beginning to look up again, and shoots $\frac{3}{4}''$ thick to arise. Repeating the complete cutting of all culms without exception for two consecutive years would here probably kill most clumps.

GENERAL REMARKS.

To work these bamboos economically, it would appear that in every clump some old culms must be left standing. A 2-year rotation leaving half the old culms may be better than a 3-year rotation felling all the old culms. But a 3-year rotation leaving some old culms would very likely be better still.

A system of working bamboos may be based on the size of the clump, on the number of new shoots produced, or on a minimum number of old culms to be left standing. But the system must be one which admits of easy check. If a proportion of the old culms is laid down as the standard, it is, in practice, difficult to check whether too many culms have been felled or not. In

the Punjab this method has been adopted, and I understand that it cannot be strictly enforced though it is said to work well in practice. Similarly, any rule prescribing a minimum number of old culms to be left based on the number of new shoots is practically unworkable.

It would be simpler to fix a minimum number of old, sound culms at least one inch thick, which must be left in each clump. But clumps vary in size. So the average size of clumps in the locality must be ascertained. If the average clump contains 20 old culms, and the rotation is 3 years, a minimum of seven old culms per clump might be fixed.

Another problem is the distribution within the clump of the culms left standing. Clear-felling part of a clump is liable to kill that part of the clump; so the culms left standing should be distributed evenly over the clump.

While a fully-stocked clump produces more shoots than a severely worked clump, there seems ground for the belief that if kept in an open condition more shoots will arise than if allowed to become congested. Loosening the earth and heaping it up round the base of a clump is likely to stimulate the sprouting of new buds.

Where bamboos have been worked continuously for years, it might be highly beneficial to give the clumps a period of rest for 3 or 4 years before introducing a new method of treatment.

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
Rotation—1 year. Proportion of culms cut—																	
At Ranipur.																	
1910 ...	1	2	16	2·9	...	18	1	16	2·4	...	37	1	14	2 6	...	1	3
1911 ...	...	4	18	3·4	8	...	10	22	3·4	2	...	4	28	3 3	0	...	5
1912 ...	...	8	17	2·2	6	...	2	21	2·6	4	...	0	...	...	...	...	3
1913 ...	...	6	17	2·4	5	...	6	20	2·1	8	...	0	...	...	...	..	3
1914 ...	...	5	14	2 2	5	.	8	18	2·6	6	...	1	6	1 2	...	...	3
1915 ...	...	5	16	2·0	3	...	6	19	2·4	3	...		Dead		...	.	2
1916 ...	...	1	Switch.		0	...	3	17	2·2	2	...	...	...	...	...	...	3
1917 ...	...	...	Dead.		...	...	2	9	1·6	1	...	...	...	...	...	...	2
Rotation—1 year. Proportion of culms cut—																	
1910 ...	3	7	16	2·4	...	21	1	16	3·4	...	43	0	...	..	...	3	2
1911 ...	...	2	21	2·5	13	...	5	26	3·9	3	...	6	28	3·3	5	...	3
1912 ...	...	13	15	2·2	5	...	3	23	3·0	4	...	5	16	2·4	7	...	1
1913 ...	...	5	17	2·0	5	...	4	22	2·8	3	...	7	19	2·4	4	...	2
1914 ...	...	5	12	1·8	4	...	3	24	3·0	4	...	4	20	2·5	3	...	1
1915 ...	...	4	13	2·0	2	...	3	19	2·6	3	...	3	20	3·0	4	...	1
1916 ...	...	2	Switches		0	...	1	19	3·2	0	...	1	19	2·9	2	...	0
1917 ...	...	0	Switches		...	...	...	Dead		...	...	2	14	1·0	1	...	...
Rotation—1 year. Proportion of culms cut—																	
1910 ..	5	0	...	...	...	20	3	13	3·6	...	49	0	...	...	...	5	2
1911 ...	...	6	20	3·0	2	...	6	22	2·8	4	...	7	22	2·6	0	...	3
1912 ...	...	2	15	2·2	1	...	4	19	1·4	3	...	0	...	...	...	...	1
1913 ...	...	1	16	2·2	1	...	3	17	2·0	2	...	2	11	1·1	6	...	1
1914 ...	...	1	14	2·0	0	...	2	15	2·0	1	...	6	11	1·9	7	...	1
1915 ...	...	0	...	...	...	...	1	11	1·9	1	...	7	11	2·0	4	...	0
1916 ...	...	0	...	...	2	...	1	Switch		...	...	4	18	2·8	4	...	0
1917 ...	...	2	11	1·8	0	...	...	Dead		...	...	4	14	1·2	0	...	...

Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.
All except new shoots. Height of cutting—Above 3 nodes.																						
At Kotdwara.																						
9	2·4	...	19	3	11	2·5	...	37	5	19	4·1	...	55	2	13	3·6	...	73	1	20	3·6	...
12	1·7	3	...	4	20	2·0	2	...	1	27	2·5	4	...	3	12	1·8	2	..	1	15	2·4	4
16	2·3	3	...	2	27	2·5	1	...	4	20	2·3	2	...	2	16	2·0	2	..	4	18	2·6	6
15	2·0	3	..	1	20	2·1	1	...	2	20	1·9	4	...	2	14	1·9	3	..	6	20	2·5	1
11	2·4	2	...	1	25	3·2	1	...	4	15	2·5	2	...	3	12	1·8	2	..	1	12	3·6	1
20	2·6	2	..	1	27	3·2	1	...	2	24	2·6	3	...	2	19	2·0	1	..	1	20	2·8	1
20	2·4	2	...	0	...	...	...	...	3	23	3·1	3	..	1	12	2·0	1	..	1	16	2·3	1
11	2·0	0	...	...	Dead		...	...	3	29	3·0	1	...	...	Dead		...	..	1	18	1·9	0
All except new shoots. Height of cutting—Above 3 nodes.																						
11	3·1	...	21	2	13	2·7	...	39	3	15	2·9	...	57	2	21	4·3	...	75	2	17	3·3	...
10	2·9	1	...	2	20	2·2	3	...	2	16	2·8	2	...	4	20	3·5	3	...	4	8	3·8	0
16	2·1	2	...	3	15	2·0	1	...	2	18	1·0	1	...	3	24	2·0	4	...	0	...	..	3
16	1·8	1	...	2	15	2·0	2	...	3	8	1·0	3	...	4	24	2·6	4	...	3	16	1·5	1
10	3·6	1	...	2	16	2·2	2	...	2	12	1·3	1	...	3	16	2·6	1	...	1	16	1·9	1
16	1·8	0	...	2	21	2·2	1	...	0	...	...	...	...	1	21	3·2	1	.	1	16	1·5	0
...	...	...	...	1	20	2·7	0	...	4	11	1·0	0	...	1	17	1·9	0	..	0	...	...	...
Dead		...	...		Dead	...	...	...		Dead		...	...		Dead		...	...		Dead		...
All except new shoots. Height of cutting—Above 5 nodes.																						
9	2·3	...	23	2	17	3·3	...	41	4	10	2·0	...	59	4	16	3·0	...	77	3	21	4·0	...
10	2·8	1	...	2	18	1·6	2	...	1	12	1·0	1	...	6	10	2·2	4	.	2	12	3·6	5
13	1·9	1	...	2	14	·9	2	..	1	13	·8	1	..	4	17	1·2	6	.	2	16	1·8	2
12	1·7	1	...	2	14	1·4	2	..	1	15	2·0	1	..	3	15	1·8	1	..	2	20	1·9	2
14	2·4	1	...	2	18	1·9	4	...	1	24	2·2	0	...	1	12	1·5	0	...	2	20	3·0	2
...	...	...	...	1	14	1·9	0	...	0	...	...	1	...	0	...	...	1	...	2	16	2·0	0
...	...	...	..	0	...	...	2	..	0	...	...	0	.	0	...	...	...	...	0	..	...	0
Dead		...	...	0	...	...	0	..		Dead		...	...		Dead		..	..		Dead		...

Rotation - 1 year. Proportion of culms cut—

At Ranipur.

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
1910 ...	2	2	13	2·1	...	19	0	...	..	...	40	0	...	...	...	2	1
1911 ...	...	2	20	2·5	6	...	6	24	3·2	5	...	3	21	2·5	0	..	2
1912 ...	...	6	11	·8	5	...	6	10	1·0	2	...	1	15	2·0	0	...	2
1913 ...		5	16	2·0	5	...	4	20	2·2	7	...	0	...	...	...	...	1
1914 ...	...	5	15	2·0	7	...	5	22	2·7	4	..	2	11	1·6	3	...	2
1915 ...	...	5	14	2·4	8	..	4	25	2·5	2	...	2	15	1·9	0	...	2
1916 ...	...	7	18	2·3	5	.	4	18	2·7	5	...	2	Switches		2	..	2
1917 ...	...	4	20	2·6	7	...	3	21	2·6	4	..	1	Swi:ch.		1	...	2

Rotation—1 year. Proportion of culms cut—

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
1910 ...	4	2	14	2·4	...	23	0	...	..	...	46	0	...	...	...	4	1
1911 ...	...	4	21	2·5	8	..	2	18	2·7	4	...	4	21	2·5	1	...	2
1912 ...	...	5	10	·8	12	...	3	15	2·0	2	...	2	20	2·0	5	...	2
1913 ...	.	9	15	2·1	11	...	2	14	1·2	3	...	2	14	1·5	6	...	3
1914 ...	...	10	14	2·0	6	...	2	13	1·6	0	...	4	18	2·0	2	...	3
1915 ...	...	8	14	2·1	12	...	2	19	2·5	1	...	3	19	2·4	1	...	5
1916 ...	...	11	15	2·4	8	...	1	...	...	2	...	3	17	2·6	3	...	6
1917 ...	...	9	17	2·1	7	...	1	16	2·1	1	...	2	14	1·2	4	...	4

Rotation—1 year. Proportion of culms cut—

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
1910 ...	6	0	...	...	...	22	1	11	1·6	...	52	0	...	...	...	6	2
1911 ...	...	2	18	3·2	3	...	5	19	3·0	8	...	4	24	2·9	0	...	2
1912 ...	...	3	15	1·6	7	...	7	13	2·0	12	...	0	...	...	2	...	2
1913 ...	...	5	17	2·3	3	...	9	17	2·0	12	...	1	10	·9	4	...	3
1914 ...	...	4	17	2·5	7	...	10	17	2·0	6	...	2	10	1·6	1	...	3
1915 ...	...	4	16	2·3	6	...	7	15	2·2	4	..	1	11	1·8	3	...	4
1916 ...	...	6	18	2·6	4	...	7	17	2·8	10	...	3	...	...	2	...	2
1917 ...	..	6	13	2·2	4	...	8	16	2·0	6	...	1	8	1·0	1	..	5

Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.
Half. Height of cutting—Above 1 node. At Kotdwara.																						
10	2·3	...	20	2	14	2·6	...	38	1	18	3·2	...	56	0	...	...	...	74	1	18	4·3	...
10	1·9	3	...	4	15	2·9	4	..	3	23	3·2	5	...	2	16	3·2	1	...	2	12	2·5	3
16	2·0	3	...	3	19	2·2	4	.	1	20	2·5	4	...	1	22	2·1	3	...	2	15	·8	3
20	1·8	2	...	4	18	2·1	5	..	3	27	3·5	3	...	2	16	1·8	3	...	3	22	2·5	4
9	3·2	2	...	4	22	3·0	4	..	3	30	3·2	5	...	3	14	2·5	3	...	4	23	3·2	3
21	2·6	4	...	5	25	3·0	5	...	3	29	3·4	7	...	3	27	3·0	2	...	3	32	3·4	4
18	2·0	1	...	1	11	2·9	0	...	6	22	3·5	5	...	2	16	1·8	1	...	5	26	2·8	5
10	1·9	2	...	0	...	...	1	...	5	33	3·6	5	...	2	19	2·2	1	...	5	29	2·7	4
Half. Height of cutting—Above 3 nodes.																						
20	4·1	...	22	1	12	3·0	...	40	1	21	3·8	...	58	1	12	3·4	...	76	2	22	5·3	...
15	4·2	3	...	1	12	2·1	3	...	2	13	1·4	2	...	3	18	2·5	5	...	4	12	4·7	7
20	2·5	5	...	2	12	1·8	3	...	2	18	2·4	2	...	3	13	2·0	7	...	5	31	3·4	9
20	2·2	5	...	2	11	2·2	3	...	2	20	2·2	2	...	5	17	2·4	5	...	6	28	3·0	1
19	3·0	4	...	3	12	1·6	4	...	2	25	2·6	2	...	4	21	3·0	7	...	6	32	3·5	5
27	2·7	5	...	3	21	2·3	2	...	3	27	3·4	3	...	6	21	2·5	4	...	6	28	3·1	10
30	3·8	6	...	4	17	2·0	2	...	2	7	3·0	1	...	6	17	2·6	2	...	6	27	3·6	6
32	3·9	4	...	2	23	2·8	1	...	1	31	3·4	1	...	3	20	2·1	1	...	8	32	3·6	6
Half. Height of cutting—Above 5 nodes.																						
16	3·8	...	24	1	13	2·5	...	42	2	16	3·2	..	60	0	...	...	...	78	3	26	4·9	...
13	2·2	2	...	4	22	1·5	2	..	2	10	1·2	3	...	2	8	2·3	3	..	6	15	4·9	9
27	3·2	4	...	3	19	2·5	4	...	3	16	1·5	4	...	3	15	2·0	4	...	7	24	2·8	9
22	3·2	4	...	3	22	2·2	3	.	3	16	2·5	2	...	2	15	1·6	2	...	8	20	4·2	11
26	3·0	4	...	2	22	2·8	2	...	2	16	1·9	3	.	3	22	2·9	4	..	8	22	2·5	9
27	4·0	1	...	3	20	2·8	4	...	3	20	2·6	3	..	2	15	2·3	4	..	11	28	3·4	12
26	4·0	4	...	4	13	2·7	3	...	3	14	3·8	3	..	4	19	2·9	2	..	9	34	3·8	9
30	4·0	4	..	3	27	3·1	2	...	3	25	3·3	2	...	3	21	2·3	1	..	10	35	4·1	10

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
											Rotation—2 years. Proportion of culms cut—						
							At Kotdwara.										
1911 ...	7	12	23	3·3	25	38	5	25	3·1	3	38	6	25	2·7	0	7	3
1913 ...	...	40	22	2·5	9	...	7	19	2·1	1	...		Dead		...	...	2
1915 ...	..	12	19	3·0	10	..	2	21	2·4	0	...	...	...	...	...	...	2
1917 ...	...	14	18	2·3	6	...	Dead		...	...	...	...	...	...	...	..	2
											Rotation—2 years. Proportion of culms cut—						
1911 ...	11	6	30	4·0	12	24	9	26	3·2	6	44	5	31	2·9	0	9	7
1913 ...		19	20	2·6	7	...	10	20	2·4	8	...	7	20	2·0	3	...	10
1915 ...	...	14	25	3·0	6	...	11	17	2·5	3	...	3	23	2·5	0	...	11
1917 ...	...	2	18	2·6	0	...	5	16	2·2	3	..	8	11	2·8	5	...	7
											Rotation—2 years. Proportion of culms cut—						
1911 ...	15	10	21	3·2	8	34	7	20	2·8	1	50	5	24	3·0	0	11	4
1913 ...	...	16	16	1·8	6	...	2	14	1·9	2	...	0	...	...	2	...	3
1915 ...	...	10	15	2·2	9	.	3	14	1·9	2	.	4	16	2·5	0	..	2
1917 ...	...	12	18	2·5	7	...	2	Switches		0	.		Dead			...	2

Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.
All except new shoots. Height of cutting—Above 1 node.																						
At Kotdwara.																						
12	1·5	1	25	6	12	3·0	3	43	4	20	1·5	2	61	9	30	3·2	6	79	3	12	4·2	2
16	2·0	1	...	5	14	2·6	3	...	4	15	2·0	2	...	13	30	2·9	2	..	3	22	2·8	2
22	2·9	2	...	5	20	2·4	6	..	4	22	2·5	2		10	38	4·1	4	.	3	25	3·6	3
21	2·4	1	...	5	23	2·0	2	...	4	27	2·8	1	...	2	36	4·3	1	..	Dead			...
All except new shoots. Height of cutting—Above 3 nodes.																						
31	3·6	5	27	3	20	2·3	6	45	4	15	1·3	...	63	5	15	2·2	3	81	4	16	3·9	2
28	3·1	5	...	8	16	2·0	3	..	5	12	2·0	3	...	5	18	1·9	2	.	4	21	2·4	3
34	4·0	4	...	6	20	2·3	3	...	4	18	2·1	2	.	2	16	2·6	1	...	4	23	2·5	0
34	4·2	4	...	3	19	1·9	2	...	2	22	2·2	1	...	Dead				..	Dead			...
All except new shoots. Height of cutting—Above 5 nodes.																						
32	3·8	1	29	5	18	3·5	2	47	5	20	1·5	0	65	3	22	2·5	1	83	14	34	3·6	5
21	2·9	1	.	3	23	2·6	1	Flowered					...	2	17	2·3	1	...	13	21	2·0	4
26	3·8	1	...	3	18	3·0	2	...	...	...	...	...	...	2	25	2·8	1	...	Flowered			
32	3·6	1	..	2	13	2·4	1	...	...	...	...	...	...	Dead				...	...			

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
						Rotation—2 years. Proportion of culms cut—											
						At Ranipur.											
1911 ...	8	6	25	3·4	3	27	3	22	2·9	2	41	3	22	2·5	0	8	2
1913 ...	...	6	18	1·9	10	..	4	21	2·0	3	...	Dead			...	...	5
1915 ...	...	9	16	2·5	2	...	4	18	2·4	1	...	...	...	...	...	...	Flo-
1917 ...	...	8	16	2·5	4	...	4	15	2·1	2	...	...	...	...	...	...	...
						Rotation—2 years. Proportion of culms cut—											
1911 ...	12	7	21	2·9	25	32	3	23	2·8	6	47	3	30	2·7	0	10	3
1913 ...	...	21	18	2·2	13	...	7	20	1·9	5	...	3	24	2·8	8	...	4
1915 ...	...	17	19	2·5	7	...	8	21	2·4	5	...	3	18	2·6	0	...	3
1917 ...	..	19	22	2·4	8	...	9	20	2·0	6	...	3	23	3·1	3	...	5
						Rotation—2 years. Proportion of culms cut—											
1911 ...	16	3	20	2·6	0	35	3	26	3·3	2	53	3	33	2·9	0	12	1
1913 ...	...	3	16	1·8	1	...	9	18	2·1	8	...	2	19	2·0	8	..	2
1915 ...	...	2	13	2·3	1	...	9	19	2·8	4	...	6	18	2·4	5	...	4
1917 ...	...	1	11	1·6	1	...	9	14	2·1	4	...	8	20	2·5	6	...	5

Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.
Half. Height of cutting—Above 1 node.																						
At Kotdwara.																						
35	4·2	6	26	3	10	3·1	4	44	2	14	1·5	2	62	7	30	4·0	10	80	3	15	4·1	3
27	4·5	0	...	4	16	2·1	5	...	3	16	2·3	3	...	13	32	3·6	9	...	2	25	3·5	6
wered		...	...	7	27	3·0	4	...	5	19	2·8	3	...	14	38	4·5	?	...	6	31	4·4	4
...	...	...	...	8	30	3·5	4	...	4	29	3·2	1	...	18	40	4·6	5	...	7	39	4·4	0
Half. Height of cutting—Above 3 nodes.																						
22	1·7	3	28	2	16	2·3	3	46	2	11	1·3	2	64	1	22	2·9	2	82	4	35	4·2	5
18	2·2	3	...	3	16	1·9	2	...	3	20	2·2	3	...	3	30	3·3	4	...	6	17	2·5	4
24	3·0	3	...	4	23	2·5	3	...	5	25	2·8	4	...	4	27	3·2	0	...	5	30	3·4	4
27	3·9	3	...	5	14	2·1	2	...	5	14	2·1	2	...	7	29	4·0	4	...	6	30	3·0	5
Half. Height of cutting—Above 5 nodes.																						
30	3·2	2	Unreliable.					48	3	14	1·1	5	66	3	12	2·5	5	84	3	18	2·8	3
32	3·1	4						...	6	22	2·6	3	...	4	18	2·2	6	...	5	19	2·5	5
41	4·0	4						...	8	24	3·0	4	...	9	27	2·9	6	...	8	24	3·8	5
30	4·1	3						...	10	26	3·0	4	...	12	26	3·5	3	...	9	30	3·1	3

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
Rotation—3 years. All cut except new shoots. At Ranipur.																	
1912 ...	9	9	27	3·2	1	25	15	25	3·4	6	39	5	14	3·1	6	13	7
1915 ...	...	10	15	2·2	9	...	15	22	3·0	2	...	15	14	2·4	5	...	8
Rotation—3 years. All cut except new shoots.																	
1912 ...	13	12	20	2·8	6	31	17	20	2·3	9	42	9	20	2·6	8	14	6
1915 ...	...	12	20	3·3	5	...	23	19	2·5	1	...	15	20	2·6	3	...	7
Rotation—3 years. All cut except new shoots.																	
1912 ...	17	10	22	3·8	5	29	20	23	2·6	20	45	8	22	3·4	6	15	5
1915 ...	...	15	25	3·4	4	...	36	21	2·5	5	...	8	20	1·4	1	...	7
Rotation—4 years. All cut except new shoots.																	
1913 ...	10	14	20	2·0	2	26	12	21	2·2	2	48	10	24	2·9	13	16	7
1917 ...	...	4	20	3·0	1	...	4	20	2·5	1	...	15	20	2·9	2	...	7
Rotation—4 years. All cut except new shoots.																	
1913 ...	14	22	20	1·9	3	33	15	19	2·2	9	51	22	24	2·9	13	17	13
1917 ...	...	19	17	2·5	7		15	16	2·5	5	...	33	26	3·0	2	...	20
Rotation—4 years. All cut except new shoots.																	
1913 ...	28	16	19	2·4	11	36	13	18	2·0	11	54	4	15	2·0	1	18	7
1917 ...	...	31	19	2·7	8	...	19	22	3·0	9	...	4	17	1·2	1		12

Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.
Height of cutting—Above 1 node.																						
At Kotdwara.																						
24	2·6	4	31	3	14	4·0	1	49	16	23	3·0	4	67	11	19	2·3	5	85	6	26	3·0	1
27	3·4	3	...	3	24	2·7	1	...	17	29	3·5	6	...	9	26	3·0	3	...	5	25	2·8	3
Height of cutting—Above 3 nodes.																						
28	3·4	2	32	4	19	3·0	1	50	7	15	1·8	4	68	7	25	3·1	3	86	12	36	4·5	5
26	3·1	2	...	4	21	2·4	4	...	12	18	2·7	3	...	6	29	3·6	1	...	Flowered			
Height of cutting—Above 5 nodes.																						
26	3·0	3	33	6	18	3·2	2	51	4	27	2·8	5	69	7	26	3·0	8	87	9	17	4·0	2
22	3·0	2	...	2	20	2·6	2	...	10	33	3·5	3	...	15	37	4·4	6	...	6	25	3·1	5
Height of cutting—Above 1 node.																						
30	2·8	2	34	24	32	2·5	10	52	6	24	3·0	2	70	21	28	3·2	4	88	17	25	4·0	5
37	4·4	1	...	27	30	3·6	6	...	3	25	2·4	1	...	Flowered				...	7	29	2·8	2
Height of cutting—Above 3 nodes.																						
25	2·2	5	35	10	20	2·1	3	53	11	32	3·6	8	71	7	29	3·2	3	89	7	24	2·1	3
34	4·0	3	...	12	27	3·2	0	...	19	37	4·2	3	..	12	29	3·1	1	..	11	33	2·2	5
Height of cutting—Above 5 nodes.																						
16	2·6	3	36	7	20	2·1	2	54	11	17	2·6	5	72	6	26	2·8	4	90	14	28	3·0	5
32	3·6	3	...	6	26	3·0	1	...	23	38	3·8	4	...	Flowered				..	30	30	3·7	4

NOTE ON THE SUPPLY OF HAY TO OUR FIGHTING FORCES ABROAD.

(Contributed.)

It is probably well known by now that some lakhs of tons of fodder are being exported overseas for the use of mounted troops, etc., in the zone of war, nor is it revealing a military secret to state that of the hay being despatched nearly one lakh of tons is being cut and baled in the Central Provinces in the present season. These provinces, including Berar, are in a good position to undertake this supply owing to the large amount of grass available, and the number of the cotton-presses which are found in the south-west of these provinces. A press worked by hand will reduce hay to a bale one-third or one-fourth of its orginal bulk. For short journeys by rail this is sufficiently convenient. A steam press again almost quadruples the carrying capacity of the wagon or ship; and, in these days of scarce freightage, it is important to make one steamer carry in steam-baled hay the quantity it would take more than three steamers to carry if it were only hand-baled. Bales turned out by hydraulic engines worked by steam are included in "steam-baled."

A 22-ton broad-gauge wagon will carry about 2½ tons of hand-baled hay and eight tons of steam-baled hay.

A fortunate circumstance is the superfluity of these cotton-presses, wherever there are large towns in cotton districts on or near the Railway. The supply of these ponderous machines is far in excess of the demand, with the result that Trusts or Combines have been formed in each town to prevent cut-throat competition.

The owner of any new press set up in a pressing centre need not trouble to work it; he simply joins the Combine so that he gets a share of the pooled profits. The result is that there are almost invariably one or more silent presses available for pressing hay.

An English farmer would open his eyes if he saw the way hay is made in India. Instead of turning the grass constantly after cutting it, the Indian grass-cutter wastes half his time tying it into small bundles, and then leaves it lying on ground not infrequently in the shade to take its chance of drying, and nothing one can do will induce him to change this time-wasting method. It is certainly convenient for reckoning in a country where weights and measures are not standardized (witness the Bengal and Bombay maund, the one of 40 and the other of 28 seers). Weight is, moreover, easily made up with water, sand or stones.

One result of this method is that, except for small private supplies for one's own cattle, it is not sound to start cutting grass too early in the cold weather when dews are heavy and there is still a chance of a local shower. Water ruins grass much more effectively if half dry than if fully hayed.

As the unit of work is the coolie, so the unit of hay is the bundle or *poola* tied up with a wisp. The *poola* varies from a half to one and half pounds in weight and for purposes of military supply, where the ton is the unit, *poolas* of slightly over a pound (to allow for wastage) are aimed at. This enables us to approximate from the number of *poolas* cut how many tons we are dealing with. The *poolas* may be supplied direct to the hydraulic press where the lead is by road and does not exceed forty miles. If, however, the hay has to be delivered to the press by rail, it must be made more portable by being first hand-baled in the forest. This reduces the bulk of the grass by at least two-thirds.

There are some half a dozen or so different kinds of hand-presses varying from Rs. 500 to Rs. 1,200 in price.

These presses turn out bales of varying size and density but it can be taken as proved that like many other articles the more expensive presses are the cheapest in the long run. The writer is in favour of the Bijoli Press costing Rs. 1,200. This turns out a small very compact bale with great rapidity. These small bales pack best in closed wagons, their only disadvantage being that they take more lashing comparatively than larger ones, but as lashings are being returned from the steam presses this

drawback is immaterial. 3½ tons of grass pressed in these small bales can be loaded into a truck which is where the saving comes in.

These presses are set up in or near the forest so that roads converging from the latter will meet at a convenient spot in relation to the railway station from which they are despatched to the steam hydraulic pressing centres.

The pressing of the bales in the hydraulic presses is interesting to anyone of a mechanical turn of mind. The grass is first stamped into a long iron box roughly four feet long, two feet wide and fourteen feet deep. A set of pistons or plungers now presses up a massive block of iron which exactly fits the long iron box until the fourteen feet of hay is pressed into a fairly solid wad about two feet thick. The blocks of iron top and bottom between which the hay is pressed are provided with deep grooves on their inner sides. Into these grooves, a huge double fork with a double set of prongs is pushed so that when the pressure is released the double fork swings out with a huge mouthful of pressed hay. The fork is now pushed into a more powerful press similar to the first but with only a short stroke and open back and front. As the lower block is forced up, the pressure on the fork becomes released and the fork is now swung out of the grooves empty and the hay compressed into slab only 15 inches thick. The grooves now permit of hoop iron, ties or wire-ropes being placed around the bale and tied as tightly as possible. The pressure is now released very gradually, the ropes or wire taking up the strain. While the tying up in the second press takes place, the coolies in the first press are filling up the deed box with a fresh load of hay. The filling and the tying being done by hand are very slow so that a lot of time is saved by these operations being carried out in two separate presses.

As at present arranged, the work of collection and delivery of the hay at the hydraulic presses or railway stations (in the case of baled hay) is done by the Forest Department.

On arrival at the press, the hay is taken over by the Civil Department who arrange for the pressing and the despatch of the completed bales to Bombay. It would probably have been better

if the whole work could have been done by one department; this was, however, rendered difficult owing to the want of sufficient supervising establishment.

As regards the work in the forest, the cutting and collection is usually done by contractors who are required to deliver the grass either at the hydraulic presses, or if the grass is delivered by rail to the nearest railway station in the form of hand-pressed bales. This method saves a good deal of trouble, as no cognizance is taken of the grass except as regards quality, until it arrives at the hydraulic press or railway station. Cases have, however, arisen when competent contractors were not obtainable and the work has to be done departmentally. Coolies have then to be paid individually on the basis of the number of *poolas* cut by them. It is usual to arrange for the *poolas* to be collected into small stacks of 2,000 odd *poolas* or one ton by the coolies under supervision. This can often be done by families or two partners working together. Carting is ordinarily not started until the stacking in any one locality is finished.

Some difficulty has been experienced with contractors, many of whom have never done grass work before, and rates have had to be fixed for them on a fair basis. The same applies to coolies who cannot be employed on this kind of work on daily labour.

As regards the various species of grass. These come into the category of "good," "bad" and "indifferent." The "good" includes *Paunia*, *Mushan* and *Shahra*.

Paunia and *Mushan* are comparatively short and fine grasses and usually found on deep or damp soils. *Poolas* of *Paunia* can be recognized by the small lumps of adherent black cotton soil which come up with the roots from the damp ground: this has, of course, to be removed and it is difficult to convince coolies that mud is not wanted in Mesopotamia. *Mushan* bears more resemblance to English hay grasses than most. *Shahra* is a very tall grass, usually found growing on hill-sides in a peculiar tufted manner, as if the clumps had been planted out artificially at regular intervals. These grasses are commonest in the south and west of the Central Provinces and Berar.

Under "bad" the writer would classify spear grass cut after the spears have fallen and he would certainly not give it to his own horses. Curiously enough, the army grass people have a great predilection for this grass, though cultivators don't care to feed it to their cattle. Horses at the front are induced to eat it by sprinkling it with water in which rock salt has beer dissolved. It is a first class thatch grass. Spear grass cut *before* the spears have completely formed is, however, quite fair fodder, though not as good as the grasses above mentioned. Unfortunately, the spears begin to form before the rains are quite over, and though private owners can arrange to hay it for their own use at this time it would be risky and impracticable to do this on a large scale. Once the spears form they are difficult to remove until they begin to twist together and "Mat." Care has, however, to be taken that spear grass is not carted or stacked while the spears are still in evidence. Owing to their hygroscopic tails, they become endowed with the power of motion as the dew forms at night and dries during the day, and to get spears out of grass which has been stacked for any length of time is only comparable with looking for the needle in the proverbial hay-stack. When the grass is in the "Mat" condition, however, the spears can easily be combed out. Spear grass is by far the commonest grass, and constitutes probably three-quarters of the grass found in the Central Provinces not including Berar.

Lemon grass also comes into the category of "bad" as animals object to the taste of the oil.

Most other grasses such as "*Gondel*" come under the head of "indifferent." Gondel is the coarse orange-coloured grass frequently seen growing near the railway line, and is one of the most widely distributed grasses to be found everywhere, especially on old fallows and field boundaries.

Before being steam-pressed, the grass has to be passed by a Military Officer who visits various pressing centres allotted to him. This officer is usually a very young Cavalry Lieutenant who, to start with, hasn't the foggiest notion of what is good or bad grass. Being the representative of the purchaser, he is not infrequently

harried in his endeavours to keep up a supply of unadulterated grass free from spears, etc., by excitable Forest Officers who tell him that unless he can pass their grass they must refuse to produce any more. However, a *modus vivendi* is usually established in a short time, and the young officer develops a remarkably keen eye for solitary spears and dirty grass. The latter is due to *poolas* cut in areas under fire-protection, which contain grass of the previous year in a condition of advanced decay. It is said rightly or wrongly to produce colic in horses, but cattle don't seem to mind it. Chewing the cud has possibly an antiseptic effect.

The luck of the BRITISH army has held with the hay season now closing. The cotton crop being barely a four-anna one, there have been plenty of carts available for carting hay, and owners of presses have been glad of the "*grist to the mill.*" In an ordinary year, the demand for carts caused by the hay business would have been difficult to meet. The wages earned by the coolies and cartmen have brought money into parts of the country where, owing to adverse climatic conditions, the crops have been more than a partial failure. Where we have been extraordinarily lucky is, however, in our weather. To have had practically no rain between November and March is almost unprecedented.

Many of the workers supplying grass have raised anxious eyes when, for a series of evenings, the clouds have gathered only to disperse without giving trouble.

The writer shudders to think what might have happened had there been a week's heavy rain any time since Xmas at the various pressing centres where, owing to want of lashing material, railway wagons, etc., there has been a "hold up" with hundreds of tons of hay rolling into the press compounds and little coming out. Once the hay carts start to roll in, it doesn't do to stop them, otherwise a big industry gets disorganized at once.

Nor so far (touch wood) have we had any big fires in spite of the somewhat haphazard methods of work.

On the whole, the Forest, Civil and Military officials have worked as one team, though occasionally some red tape wallah has butted in with the letter of the law in his mind evidently above the spirit

of the undertaking, which it need hardly be added is "Don't waste time but help WIN the WAR as soon as possible."

The experience of the current year should not be lost and there are many points at which improvement can be effected. We all hope that the WAR will be over before next year, but the probabilities seem to point to a considerable demand for hay in 1919. The writer is not aware whether it is possible to divide hay into two classes according to quality for use at the front, but a business firm would probably not only do so but also be prepared to pay a higher rate for the better quality. To take an instance, should the WAR stop suddenly and there be numbers of bales of hay for sale in Bombay, those bales containing *Shahra* would fetch a good price, whereas those containing the old spear grass would probably be unsaleable. It would probably be worth our while to cart *Shahra* or *Paunia* longer distances at greater expense, so as to increase the proportion of this grass at the expense of the spear grass. Curiously enough, spear grass and "*Gondel*" are costing Government more than the better quality grasses, owing to the fact that the distance by rail from the forests containing the latter to the cotton-presses is less. In fact, the bulk of the *Shahra* and *Paunia* grass is carted direct to the cotton-presses and has to be either hand-baled or railed. The cost of railway is not, however, paid by the Forest Department and so does not come into their calculations.

In future, provision should be made to provide sheds at or near the pressing centres for storing loose grass in the event of a "hold up." Usually a press can keep pace with a very large team of carts and can, if necessary, work both night and day, but even then there must always be at least four days' supply handy for the Military Officer to pass. The present system of allowing hundreds of tons of hay to be exposed to the weather for months is asking for trouble.

If possible, one Military passing officer should be attached to each district so as to avoid dangerous accumulations in his absence. At the same time more use might be made of the passing officer. He could easily be placed in charge of the press work and work directly under the Minister of Munitions. The pressing and

despatching work devolves quite unnecessarily on the overworked Deputy Commissioner, and when he is out in camp a good deal of valuable time may be lost by orders having to be communicated through him. The passing officer would have plenty to do taking delivery, keeping tally of the bales and arranging for their despatch by train. In most districts there are three or more pressing centres, so he would have his work cut out. A comparatively small addition to the number of passing officer now employed would meet the situation.

F. T.

NOTES FOR THE USE OF DYE-WOODS.

BY T. SINGTON, OF MARSDEN CHAMBERS, MARSDEN STREET, MANCHESTER.

The scarcity of dyes during the last two years has drawn attention to the properties of dye-woods, some notes on the strength and purity of some dyes yielded by them may be useful for reference, and may encourage the production of dye-woods in India and a search for possible supplies not now known. One of the most important sources of vegetable dyes is logwood. The dyer must either buy his logwood in the log form as imported, and both cut and mature it himself, or he must purchase it chipped, rasped, or as an extract, which may be in the form of powder, or paste. Chipped wood is, as the word implies, in small chips or flakes and is usually somewhat cheaper than rasped wood, as it requires less labour, but the colour is more difficult to extract and the maturing cannot be so thorough. It can only be used for goods in which the chips cannot get entangled, so that for many purposes it is not available. Rasped wood is like coarse saw-dust and is the form commonly used by manufacturers of woven goods. It is important to note, that this rasped wood should be quite free from "gripps," which are dark needle-shaped splinters ; they should be shifted out by the grinder before the wood is matured. An approximate opinion of the condition of rasped wood may be obtained by experts, from the way it rubs up in the hands, which should be quite dry and clean during the experiment. The colour should be

rich crimson red, neither tending to yellow nor brown. Should the experiment yield a yellowish shade, it is obvious that the dye has not been sufficiently matured and the wood may be described as young, but if the resulting colour is a brown, it suggests that the fermentation has been carried too far, so that a considerable percentage of the colouring matter has been lost.

The colouring principle of logwood is a yellowish-white crystalline body known as haematoxylin, which is readily soluble in hot water, but which has to be oxidized before the colour is developed. After being cut from the log, the rasped or chipped wood is generally laid in heaps, or beds about 18 inches deep, which require to be well and repeatedly watered and turned over as well from time to time. This treatment results in fermentation being set up in the course of a few days, accompanied by a considerable increase of temperature, which must not be allowed to exceed a certain limit, lest the colouring matter should be changed to a brown resinous body, with a very considerable waste of strength. A high temperature hastens the fermentation and may necessitate a more frequent turning over of the heaps or beds, at least once daily, so as to maintain the heat within limits. Cold weather has, of course, the opposite effect, the maturing is retarded and twice the time is required during the winter. A frequent watering with very weak solutions of alkalies, glue water or urine, assists the maturing of logwood, but the system involves considerable risk, as it may cause a too rapid fermentation. Alkalies oxidize the haematoxylin into the red colouring matter haematin very rapidly and not only import a rich crimson colour to the wood, but cause it to bleed freely and appear to be rich in dye. The brousy appearance seen on dried logwood is due to the ammonia salt of the colouring matter, not to the colour itself. Logwood, which has been treated with alkalies, is much more likely to deteriorate with keeping, than that matured in a natural way, as the alkaline combination is acted upon quicker by the air, forming a useless brown resinous matter at the expense of the dye. Urine is a favourite agent for watering, as it is much safer to use than soda-ash, or other chemicals and is much more difficult to detect.

GERMINATION OF *CUPRESSUS TORULOSA* SEED.

BY MATHURA PRASAD BHOLA, P.F.S.

The considerable failure of direct sowings of *Cupressus torulosa* in the past, led me to carry out small sowing experiments in flower pots in my bungalow at Pauri (elevation about 6,000 feet) in the monsoon rains of 1917. The seed was sown in the pots early in the month of July, after being subjected to the following four separate processes:—

(*a*) Soaking the seed for 24 hours in water before sowing.

(*b*) Mixing the seed with cow-dung 24 hours before sowing.

(*c*) Sowing without subjecting the seed to any process.

(*d*) Keeping the seed for three minutes in boiling hot water before sowing.

The results obtained are shown below:—

Process of preparing the seed before sowing.	No. of days the seed took in germinating.	Percentage of success in germination.	REMARKS.
(*a*)	12	69	The pots were kept in the open, exposed fully to the effects of rain and sun.
(*b*)	10	66	
(*c*)	12	70	
(*d*)	15	2	

The results of experimenting with processes (*a*), (*b*) and (*c*) are practically the same, though process (*b*), that is, sowing the seed 24 hours after mixing it with cow-dung, accelerates germination. Process (*d*) was a failure, owing apparently to the adverse effect of boiling hot water on the vitality of the seed.

Seeds were sown at the same time in nursery beds in lines, and in the forest near Pauri in patches made in well-prepared soil. The germination took place two to three weeks after sowing, whereas the seed sown in August 1916 germinated only in the following October.

The earlier germination in 1917 was due to the constant soaking the seed received from the heavy and continuous monsoon rains

of that year, which conditions did not hold in 1916. The seed sown in the forest in the winter of 1915-16 resulted in almost complete failure on account of scanty rains.

The conclusions arrived at from the above observations are that, in order to attain success, both in direct sowing and in nursery beds the seed of this cypress should be sown soon after the break of the monsoon rains, so that it may have the whole of the wet weather before it in which to germinate. If this is done, *there is no real necessity of preparing the seed by mixing it with* cow-dung before sowing. Winter sowings generally result in failure and are not recommended.

EXTRACTS.

INDUSTRIAL COMMISSION AT MANDALAY IN BURMA.

The following is an extract from the statement made to the Industrial Commission at Mandalay on the 31st January 1918 by Mr. A. E. English, C.I.E., I.C.S., whose opinion, matured by very long and intimate connection with Burma, is of the utmost value :—

"As I have said above, the main industry of this province subsidiary to agriculture should be the lasting one of the exploitation of its forests. The forests are extensive and contain an enormous variety of trees, many of which are valuable. They also contain much other produce of commercial use. If properly conserved they not only persist but improve, and in this respect are unlike mines and oil-fields. They are well placed all about the country and, in my opinion, one of the very first things to do in promoting industries is for Government to provide an adequate forest staff

to develop these forests to the best advantage. It is of course necessary to develop other useful industries such as leather working, pottery, weaving, etc.; but it is certain that the forests can provide remunerative occupation for all classes of the community from cooly to capitalist for years to come, provided they are properly conserved and worked. The policy of the past appears to have been in forest matters to get the maximum revenue with minimum establishment, regardless of waste. It is the long view that must be taken and the proper policy should be to put on the full staff now with a view to continuous and progressive development until the maximum extraction and revenue are arrived at in perhaps fifty years. We require silviculturists, research officers, working-plans officers, commercial officers, revenue collectors and forest engineers. We want capital for forest roads, for forest railways, for forest machinery, for silviculture and for improvements."

WORST LOG JAM IN HISTORY.

A misfortune altogether without precedent has befallen those branches of the wood goods industries which obtain their raw material and logs from the Glommen River district. The Director of the Association, under whose management lies the floating of the logs in the River Glommen, has sent the newspapers for publication, a letter which he has addressed to the Association of forest owners.

An immense quantity of logs should be floated down the river; a late spring and a rapid thaw have caused a quantity, estimated at about 450,000 dozens of logs to be piled up at Bingfoss lock, tied one with the other almost inextricably in an enormous height, and it is only possible to extricate the logs one by one with immense work and difficulty. Instead of employing usually about 20 to 30 men, the Association has now 130 men engaged who work night and day to try to loosen this mighty mass of timber. Although everything has been done to stop more timber from coming down to Bingen, the river still carries a great

deal of timber, and the quantity at Bingfoss is thus steadily increasing.

"As the situation now is," says the Director, "it is hardly probable that we shall be able to clear the timber at the Bingen lock in a shorter time than two years and there is no prospect of being able to release this year much more than one-half of the quantity of timber which has been marked this season for being floated in the Glommen River."

This very serious situation will prevent not only the mills but also the many parishes who have bought timber in lieu of coal, from receiving the timber which has been cut and marked for their account for being floated in the Glommen River And, still more, it will not be advisable for the mills to contract for logs, in the autumn, for cutting and for floating next spring. It is, therefore, more than probable that the saw, cellulose, and mechanical wood-pulp mills which receive their timber by floating in the Glommen will be compelled to stand idle for one year, as soon as they have used up their present stocks of timber.

This is an event which is without any parallel in the very long time which has elapsed since floating of logs in the Glommen River commenced, and it will affect the planing mills at Fredrikstad, among other cellulose mills the large mills belonging to the Kellner-Partington Paper Pulp Co., the Greaker cellulose mill, and all the other mills which are situated by the Glommen River, but more or less all pulp mills in the south of Norway will be inconvenienced by this stoppage, for all of them obtain at least a part of their log supply from the Glommen River district.—[*Farmand.*]

Extract from the "Near East," dated 10th August 1917.

CYPRUS NOTES.

THE PROBLEM OF GOATS.

Rustem Pasha, when Governor of the Lebanon, used to say that what gave him most trouble was the goats and the priests. In Cyprus the question of goats has always been a source of worry and anxiety; but, unfortunately, it has never been handled with the firmness that the circumstances required. Just as the preservation of what remained of the forests became one of the principal subjects of consideration for the British Administration, so the depredations of goats called for serious attention and repressive measures. The British Government at once took in hand the protection of the forests, though with quite inadequate means at its disposal. On the other hand, the evil caused by goats both to forests and agriculture was left to a great extent unchecked. It is precisely as if a patient were treated methodically for a serious complaint, while allowed at the same time to indulge in a poisonous luxury which undermined the whole system.

INJURY TO FORESTS AND AGRICULTURE.

The earliest and best report on the Cyprus forests by M. Madon, an officer lent by the French Government, stated clearly the lines upon which forest policy should be based. All authorities have insisted on the fact that forest growth and the grazing of goats are incompatible. Anyone, indeed, who has studied treatises on the subject is perfectly well aware of this truth. Flocks of goats, however, have been allowed to exist and multiply in Cyprus, with the result that the island has suffered year by year injury which the principal Forest Officer has endeavoured roughly to estimate in recent reports. It would have been far better in the long run, had the Government taken a firm line from the outset, and, putting up with perhaps a little outcry from a particular class had served the general interests of agriculture by the reduction or destruction of this inveterate foe to husbandry. No doubt there

would have been some bitter feeling and grumbling, even outside the flock-owning class; but that has been the case wherever action has been taken against goats.

As regards the State forests, the delimitation of which was undertaken in the early years, goats were excluded (though in a few localities rights to graze, possessed at antiquo, were respected); but, of course, much depredation must inevitably take place over large areas which cannot be adequately patrolled by the small staff of forest guards. As to private properties the difficulty has been great, but in reality it only required firm handling. It has been left to the Legislative Council to discuss what remedies should be adopted, and the results up to date have certainly not been satisfactory. A law passed a few years ago allowed the inhabitants of any village to decide by majority whether goats should be tolerated in their lands or not. A fair number of villagers have taken advantage of the measure, but ambiguities as to its application have rendered amendments necessary.

Either Goats or Agriculture.

Fortunately it would seem that the good sense of the native communities is at last tending more and more in favour of eliminating this island plague. At any rate, it is very satisfactory to know that there are now members in the Legislative Council who have the courage to defend a strict forest policy and war upon goats. No one has insisted on this more vigorously than Mr. Theodotou, one of the members for the Nicosia-Kyrenia division. A short time ago he warned his countrymen that it was a choice between goats and agriculture, and told them plainly that goats were just as great a pest as locusts. He aptly referred to the case of Algeria, where, owing to measures such as are required in Cyprus, the area of forest land has been quadrupled in about forty years. "Whenever I go on district tours," he said, "and advocate tree-planting, I hear the same reply: 'Let us plant trees, in order that shepherds may destroy them.' No wonder our agriculture does not advance." Those who kept goats, he continued, were in reality condemning the country to economic disaster, and he

expressed himself in favour of the gradual abolition of goats "in order that the resources and productiveness of our fields and forests may prosper and be further developed." Breeds of sheep and cattle, he rightly argued, should be raised in their stead. Mr. Theodotou stated, as an example of the mischief caused, that in one village 3,000 trees were planted a few years ago, and of these all but thirty were destroyed by goats or shepherds. If a villager prosecuted a shepherd, and a fine was inflicted, next day he might find his animals mutilated, his trees cut down, his crops destroyed, or even his life in danger. This is one aspect of rural life in Cyprus. Very large sums have been spent in the destruction of locusts, and it might have been wise and expedient to devote a sum annually to the compensation of flock-owners while compulsorily reducing this other pest of the agriculturist.

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RECENT INVESTIGATIONS ON SOIL-AERATION.*

PART I.—WITH SPECIAL REFERENCE TO AGRICULTURE.

BY ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S.,
IMPERIAL ECONOMIC BOTANIST.

PART II.—WITH SPECIAL REFERENCE TO FORESTRY.

BY R. S. HOLE, F.C.H., F.L.S., F.E.S., BOTANIST, FOREST RESEARCH INSTITUTE, DEHRA DUN.

PART I.

I. INTRODUCTION.

The growing of a crop is an exercise in applied physiology. This operation, as is well known, is only possible through the simultaneous operation of a number of soil factors—water, mineral salts, temperature and oxygen. What is not always fully realized is that if any one of the factors concerned, for example the supply

* A lecture delivered to the Indian Science Congress at Lahore on January 9th, 1918.

of combined nitrogen, is in defect, growth is checked and stops altogether when this substance is no longer available. Nitrogen is then said to be a limiting factor in growth. On the addition of a further supply of this substance, growth at once recommences and proceeds till the crop is ripe unless some other factor becomes deficient. A crop, limited in growth by a deficiency in the supply of any particular factor, is not influenced by the increase of other factors. Thus a shortage of combined nitrogen is not made up for by the application of phosphates or potash or by increased irrigation. Just as the strength of a chain is limited by that of its weakest link, so the growth of a crop depends on the factor in greatest defect.* The chief object in soil-management is the removal, in advance, of any possible limiting factor which may operate adversely.

The aeration of the soil is a factor in growth which has been greatly neglected in the past. The three substances involved—oxygen, nitrogen and carbon dioxide—are gases which are invisible and are not on the market in the form of artificial manures like nitrate of soda or superphosphate of lime. Only very indirectly has soil-aeration been recognized in the European literature on agriculture in the importance attached to a proper soil texture. Soil texture is really important because of its influence on soil-aeration. In this lecture it is proposed to refer to some of the recent work on soil-aeration and to indicate the direction in which further investigation is needed particularly in the irrigated tracts of India.

II. Aeration and the Amount of Growth.

If growth is influenced by the aeration of the soil, the effect of this factor should be apparent in any series of cultures where all the conditions are uniform except the ventilation of the roots. A number of investigations have recently been carried out on this point from which the following examples are taken :—

1. *The effect of increased aeration on the root development of barley.*—This matter is dealt with in one of Mr. Hall's papers in

* In the case of the temperature factor, growth is also limited when the optimum is exceeded.

the *Philosophical Transactions* (B, vol. 204, 1913). One example taken from this paper will suffice.

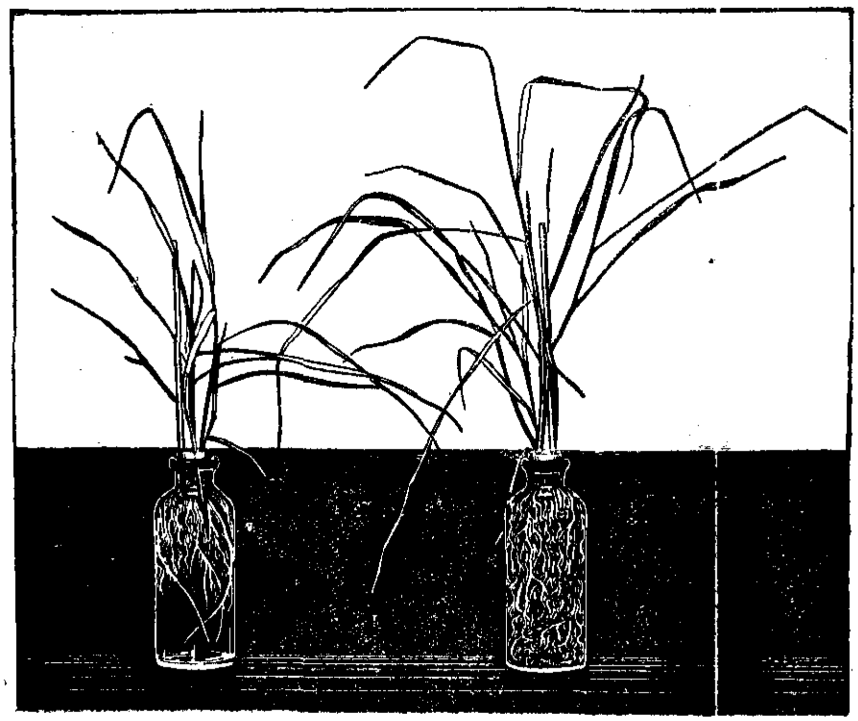

Fig. 1.—Growth of barley in solutions aerated once a day (left) and aerated continuously (right).

On the screen are represented two water cultures of barley (Fig. 1). The bottle on the left was aerated once a day, that on the right was aerated continuously. It is clear that both root development and growth depend on the amount of aeration.

2. *The effect of soil texture on growth.*—The results published by Mr. Hunter in vol. IV of the *Proceedings of the Philosophical Society of the University of Durham* show the marked effect of soil texture on growth. Various kinds of soil were used and the plants selected were sunflower, peas, wheat and cress. Five degrees of soil texture were adopted as follows :—

1. Soil in small lumps, loose.
2. Soil fine, loose.

3. Soil fine, firm below, with a loose surface.

4. „ „ firm.

5. „ „ hard.

The results obtained are shown on the two following slides (Figs. 2 and 3).

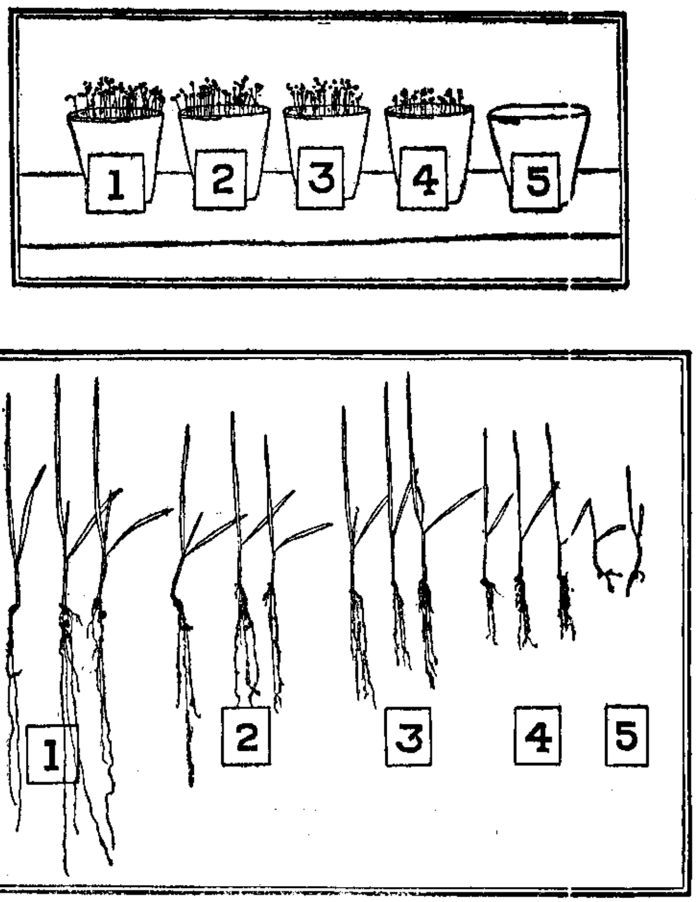

Fig. 2.—The effect of soil texture on the growth of cress and wheat.

The first (Fig. 2) shows the effect of soil texture on the growth of cress and wheat. Where the soil was hard, the cress seeds did not germinate. In the case of wheat, the effect of the texture on root development is very clear. The closer the packing, the poorer

the growth. The corresponding results with peas are shown on the next slide (Fig. 3).

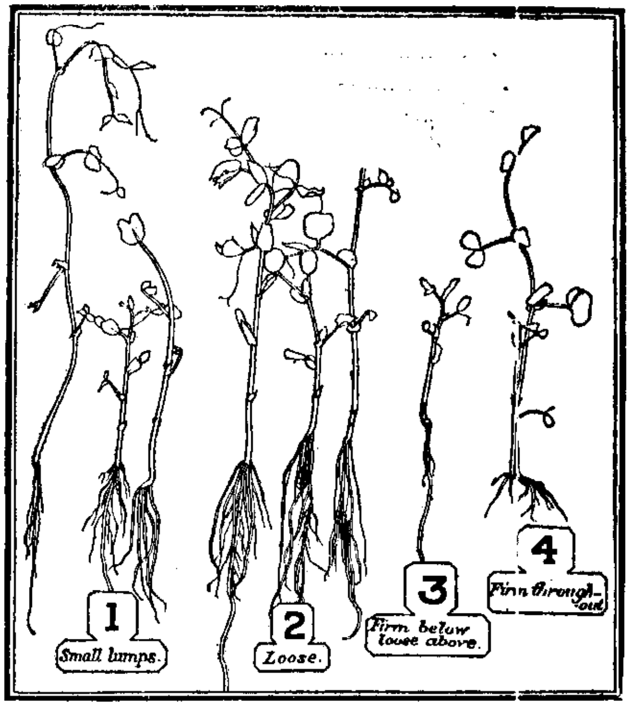

Fig. 3.—The effort of soil texture on the growth of peas.

Here the best growth was obtained where the soil was fine and loosely packed. Mr. Hunter next measured the effect of soil texture on the resistance to an artificial air current. It was found that the resistance of columns of soil were in accordance with their textures. The results are to be seen in the table on the screen.

TABLE 1.—*Soil texture and air movement.*

Description of soil.	Height in cm.	Resistance offered.
1. Small lumps, loose	35	1 unit.
2. Fine, loose	35	2 units.
3. Fine, firm below with loose surface ...	5 } loose 30 } firm	} 17 ,,
4. Fine, firm throughout	35	42 ,,
5. Fine, hard throughout	35	310 ,,

3. *The effect of adding potsherds or sand to the Pusa soil*.*— The soil at Pusa is a calcareous silt which readily forms a surface crust and often loses its texture altogether after long continued heavy rain. The addition of one inch of potsherds to the heavy soils of the botanical area increases the yield considerably. Some of the results obtained are given in Table 2.

TABLE 2.—*The effect of diluting the Pusa soil with potsherds or sand.*

1. Wheat, oats and tobacco.

Crop.	Yield per acre of control plot.	Yield per acre with one inch of potsherds.	Increase per acre.	Percentage increase.
	m. s.	m. s.	m. s.	
Oats	24 17	28 36	4 19	18
Wheat	16 18	19 30	3 12	20
Tobacco	21 0	23 3	2 3	10

2. Indigo.

Kind of soil.	No. of plants measured.	Average length in cms.	Percentage increase.
Soil only	33	36·7	0
50 °/o soil + 50 °/o sand	36	51·6	40
90 °/o soil + 10 °/o potsherds	33	48·3	31
70 °/o soil + 30 °/o potsherds	35	50·9	38

These examples, selected from many others, are sufficient to illustrate the main fact that soil-aeration is one of the factors on which the growth of plants depends.

The structure of the soil.

To follow the subject further, it is necessary to consider the structure of the soil and the relation of this structure to the root

* Howard, A., *Bulletin* 61, *Agr. Research Institute, Pusa*, 1916.

system of the plant. The soil consists of particles with intervening spaces between them known collectively as the pore space. For every soil, the proportion of the volume of this pore space to the total volume of the soil varies with the closeness of packing. When the soil texture is good, the pore space is large. Afte heavy rains and when water-logged, fine silt-like soils run together into a condition of close packing when the pore space is considerably reduced. Thus the volume of the pore space varies according to circumstances. The pore space is taken up by two things—water and air. The water occurs in thin films round the soil particles, while the soil air fills up the rest of the pore space. The next slide (Fig. 4) represents the structure of the soil, in relation to the root hairs of a crop.

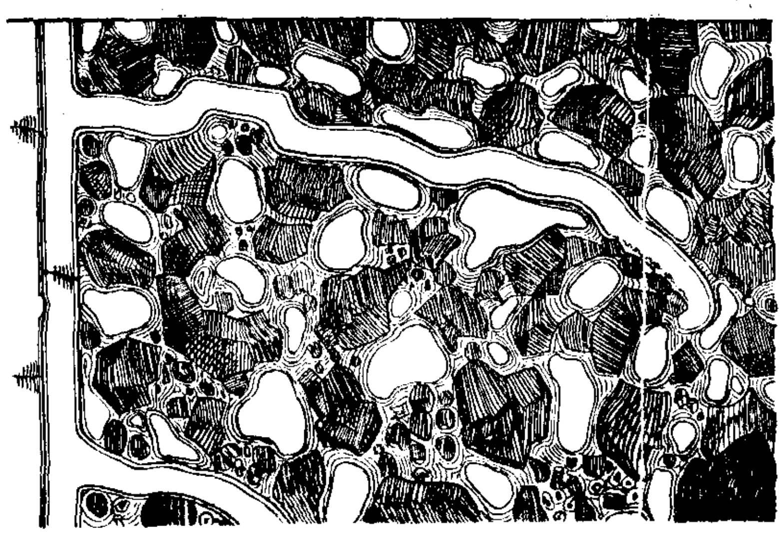

Fig. 4.—The soil in relation to the root hairs of a plant. The solid soil particles are darkly shaded, the air spaces are white, the adherent water is ind cated by concentric lines. From the piliferous layer of the root two root hairs arise. (After Sachs.)

In the water films round the particles there is intense biological activity. New root hairs are constantly being produced by the plant which, for a time, absorb water and dissolved materials and then die. Various soil bacteria are occupied in the decomposition of organic matter. Both these activities involve

the process of respiration. The working protoplasm in each case uses up oxygen and carbon dioxide is produced as a by-product. The soil atmosphere is, therefore, constantly being called upon to supply oxygen for respiration and receives fresh supplies of carbon dioxide. Efficient ventilation is clearly essential if the air in the pore spaces is to be kept fresh. Supplies of oxygen must pass into the soil from the atmosphere and at the same time the excess carbon dioxide in the pore spaces must diffuse out in the reverse direction. The pore spaces are the living rooms of a vast undergrouud city, the inhabitants of which require fresh air.

It is only very recently that investigators have begun the systematic study of the soil atmosphere in relation to the biological activities proceeding in the soil. Important and interesting results are being obtained at Dehra Dun by Messrs. Hole and

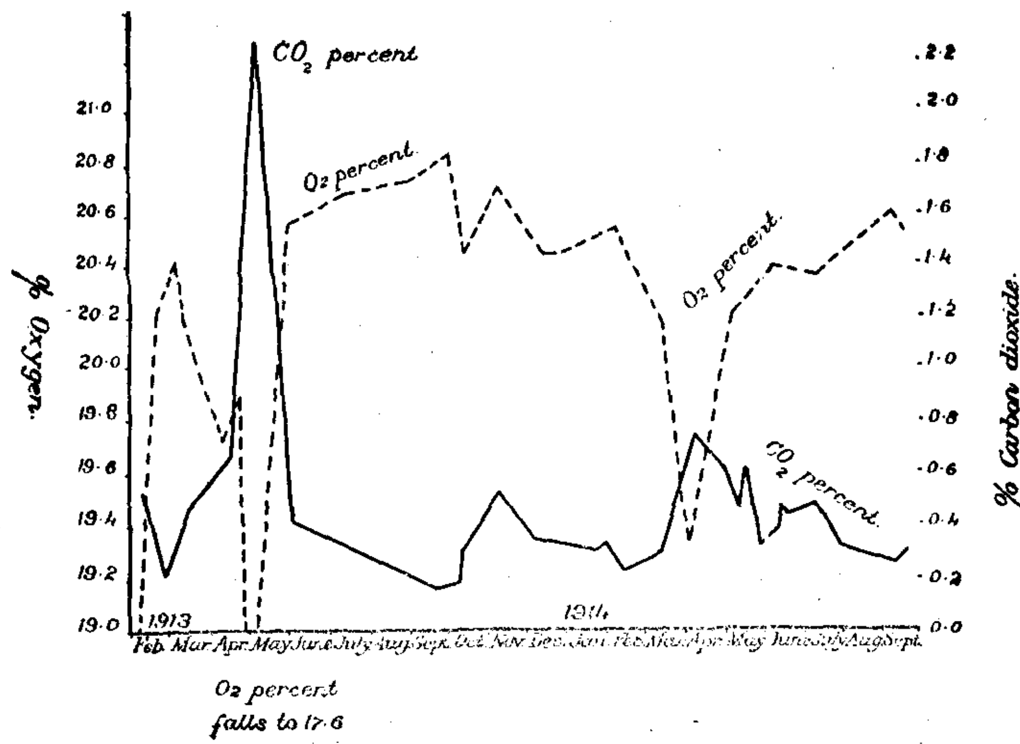

Fig. 5.—Curves showing percentages of CO_2 and of O_2 in soil air in Broadbalk dunged plot.

Puran Singh and at Rothamstead by Dr. Russell and his colleagues, some of which have been published. In general, Dr. Russell and Mr. Appleyard* find that the oxygen and carbon dioxide curves are reciprocal—the oxygen falls as the carbon dioxide rises The agreement is sufficiently close to justify the assumption that the oxygen is mainly used up in producing carbon dioxide. One of these curves is shown in the next slide (Fig. 5).

These investigations also throw considerable light on the composition of the gases dissolved in the water films. These contain very little oxygen but a great deal of carbon dioxide as will be evident from the figures in the next slide (Table 3).

TABLE 3.—*Composition of gas held absorbed by soil. Percentage by volume.*

	Weight of soil used, grms.	Percentage of moisture.	Approximate vol. of gas removed in successive extractions.	Percentage composition of gas.		
				CO_2	O_2	N_2
Pasture soil ...	352	28	1st 30 c.c.	52·0	0·7	47·3
			2nd 30	84·8	0·2	15·0
			3rd 22	99·1	0·2	0·7
Soil covered with vegetation (Broadbalk wilderness).	400	22	1st 30 c.c.	19·3	5·5	75·2
			2nd 30	57·0	2·6	40·4
			3rd 15	98·7	0·2	1·1
Rich garden soil ...	468	20	1st 30 c.c.	89·5	0·2	10·3
			2nd 30	99·3	0·0	0·7
			3rd 15	99·4	0·0	0·6
	extracted later		4th 30	96·8	0·0	3·1
			5th 30	92·3	0·0	7·6
Arable soil (Broadbalk dunged plot).	...	24	1st 30 c.c.	10·8	4·4	84·8
			2nd 30	57·9	1·8	40·3
			3rd 15	98·4	0·0	1·6
Broadbalk unmanured	497	16	1st 30 c.c.	6·3	15·1	78·6
			2nd 25	40·2	9·7	50·1

The essential point is that the water films are exceedingly poor in oxygen but very rich in carbon dioxide. As they are

* Russell, E. J., and Appleyard, A., *Jour. of Agr. Sc.*, VII, p. 1, 1910.

the seat of an intense biological activity for which oxygen is essential, it is clear that the consumption of oxygen in the film is equal to the rate at which it is renewed. The details relating to the gaseous exchanges between the pore spaces and the water films need much more investigation and a further contribution has been promised by Dr. Russell. On physical grounds, we should expect that the water films would derive their supplies of fresh oxygen from the air in the pore spaces. The Rothamstead experiments, however, have disclosed another source, namely, the oxygen dissolved in the rain-water.* Rain was found in most cases to be a saturated solution of oxygen which stimulated markedly the biological activities in the soil. The effect of showers of rain was found to be greater than that produced by water alone and could be explained by the influence of the dissolved oxygen in replenishing the supply of this substance in the water films. That rain benefits crops has long been known and practical men have always felt that something more than a moisture effect is concerned. We know now that rainfall supplies both water and oxygen in the most effective form. In future, we must think of the Indian monsoon not as the distribution of so much rainfall over certain areas but rather of so much water rich in dissolved oxygen.

It will now be clear that one of the essentials for the growth of plants is the maintenance of the oxygen supply of the pore spaces and of the water films round the soil particles. The soil must be kept ventilated or the denizens of our underground city will languish for want of air. Let us study the ventilation of our underground city in connection with flood irrigation as practised by the cultivators all over Northern India. The soil is alluvial in nature. Its texture deteriorates if it is flooded with water. As it dries under the hot sun, the surface bakes into a crust largely impermeable to air. That the crust is impermeable can be seen by immersing in water a portion of the hardened surface soil after irrigation. The air escapes sideways not through the surface skin. Each successive irrigation destroys the soil texture still more and

* Richards, E. H., *Jour. of Agr. Sc.*, VIII, p. 331, 1917.

the surface crust becomes more and more impermeable to air. The effect of irrigation on alluvial soils, therefore, interferes with its ventilation. The process removes one limiting factor, the want of water, but it introduces another, namely, the need of aeration. That this is so will be clear from Table 4 which contains the result of a recent experiment at Quetta.

TABLE 4.—*The introduction of a new limiting factor after irrigation.*

Number of waterings.	Area in acres.	Total weight of produce.	Total weight of grain.	Yield of grain per acre.	Percentage reduction.
		lbs.	m. s.	m. s.	
One	3·99	10,367	52 6	13 2	0
Three	2·65	6,620	25 15	9 23	26

Here the last two irrigations reduced the yield through the introduction of another limiting factor—the need of soil-aeration. Clearly if we could work out a practicable compromise between the needs of the soil for water and for air under irrigated conditions, an immediate advance in agriculture would result. This has recently been accomplished at the Quetta Experiment Station. I propose to indicate briefly the manner in which it was done. The Quetta valley is typical of the upland valleys of Baluchistan. The soil resembles that of the plains of India and the characteristic of the climate is the dryness of the air and the amount of air movement. It is a dry, windy place. Irrigated crops, therefore, require an enormous quantity of water. Irrigated wheat is often watered six times and the crop shows all the symptoms of poor soil-aeration—excessive liability to rust attacks, slowness in ripening and shrivelled grain of poor quality. The irrigated wheat dries up rather than ripens and the bright straw and shining chaff which are so characteristic of this crop are not developed in the Quetta valley. It was obvious that enormous quantities of valuable irrigation water were being thrown away to

no purpose on the wheat crop. A method of growing the crop on a single irrigation was worked out which is now being taken up by the cultivators. The method consists in making full use of the preliminary irrigation before sowing and the breaking up of rain crusts afterwards. The details of the method are to be found in the bulletins* issued by the Quetta Exper ment Station. Under the new method, the yields are often higher with one irrigation than with six or seven. Harvest is about a month earlier and the wheat ripens normally and develops the characteristic colour of the chaff and straw.

As the wheat crop on the Canal Colonies of the Punjab also exhibits definite signs of want of soil-aeration during the ripening period, I ventured to predict that at least one-third of the irrigation water now used on this crop is wasted. The matter was put to the test of experiment during the wheat season of 1916-17. The Punjab results are given in Table 5.†

TABLE 5.—*Results of water-saving experiments on wheat (Pusa 12) at Gungapur, Haripur and Sargodha in 1916-17.*

Station.	No. of irrigations including the preliminary watering.	Yield per acre.		Average yield per acre.	
		Grain	Bhusa.	Grain.	Bhusa.
		m. s.	m. s.	m. s.	m. s.
Gungapur ...	One	12 19½	20 10	9 34	21 17
Haripur	,, ...	8 31	19 14		
Sargodha	,, ...	8 12½	25 27½		
Gungapur	Two	18 0	25 8	16 11	25 5
Haripur	,, ...	15 21	23 16		
Sargodha	,, ...	15 12½	26 32½		
Gungapur	Three	14 25	18 0	15 11	22 2
Haripur	,, ...	16 8	26 4		

An inspection of the figures shows very clearly that after the second irrigation water ceased to be a limiting factor and then began to depress the yield. Similar but still striking results were obtained by Mr. Main at Mirpurkhas in Sind. The significance of these results will be apparent when it is remembered

* Howard, A. and Howard, G. L. C., *Bulletins 4 and 7, Fruit Experiment Station, Quetta*, 1915 and 1917.

† Annual Report of the Imperial Economic Botanists, 1916-17.

that the annual revenue derived from irrigation works in India is about £5,000,000 sterling. Taking the Indian Empire as a whole, there can be no question that the water wasted every year would, if used to the best advantage, bring in a very large direct and indirect revenue to the State.

III.—SOIL-AERATION AND QUALITY.

The quality of vegetable products, as is wel known, varies greatly with the locality. The quality of the wines of Champagne and of the tobacco grown on certain soils in Cuba depend to a great extent on the soil of these tracts. The transference of the vines of Champagne or of the tobacco plants of Cuba to other places does not mean the transfer of the special qualities associated with the wine and cigars produced in these localities.

What are the factors on which quality depends? The breed or variety is certainly one. A rough short stapled cotton for example can never be transformed by alteration in the environment so as to resemble the best Egyptian or Sea Island types. Such a cotton can be improved to a limited extent but the fibres will always remain coarse and short. It is suggested that besides the variety, quality also depends on another factor, namely, adequate soil-aeration. Many examples can be quoted in support of this view. It will be sufficient to mention the following :—

1. *Barley.*—The barley crop is grown all over England, the best samples being used for making malt. For the best beer, the barley grain must be well filled with starch so as to produce a rich clear malt-extract. Such barleys are always grown on light land where the natural aeration of the soil is good and where the crop ripens off quickly. On stiffer soils, the aeration is bad, the barley ripens slowly and the grains are often poorly filled with starch. Malsters do not like these barleys as they give a thin, cloudy extract.

2. *Tobacco.*—As is well known, the internal tobacco trade of India is enormous. Certain tracts such as the Parganah Saraisa in Tirhoot, Jais in the District of Rai Bareli and the Mustung valley in Baluchistan have achieved a reputation for quality which is well known in the trade. In all these places, the soils which produce the best qualities are those in which the aeration is much above the average.

3. *Cotton.*—Recent investigations in the Central Provinces indicate that soil-aeration is one of the factors on which the staple of cotton depends. Mr. Clouston has shown that on the open laterite plains near Raipur where the soil is such that its texture cannot be destroyed by heavy rain or surface flooding, long staple cotton of high quality can be produced. Further, the fibre of coarse cotton like Roseum is improved when this type is grown on these laterite soils. Similar results are obtained with other crops like ground-nuts and sugarcane.

No scientific explanation of the part played by soil-aeration in the development of quality has yet been put forward. The recent Rothamstead results, however, appear to throw light on this point.* If we compare the carbon dioxide in the soil atmosphere from cropped and uncropped land, two marked differences disclose themselves. The curves are to be seen on the last slide (Fig. 6).

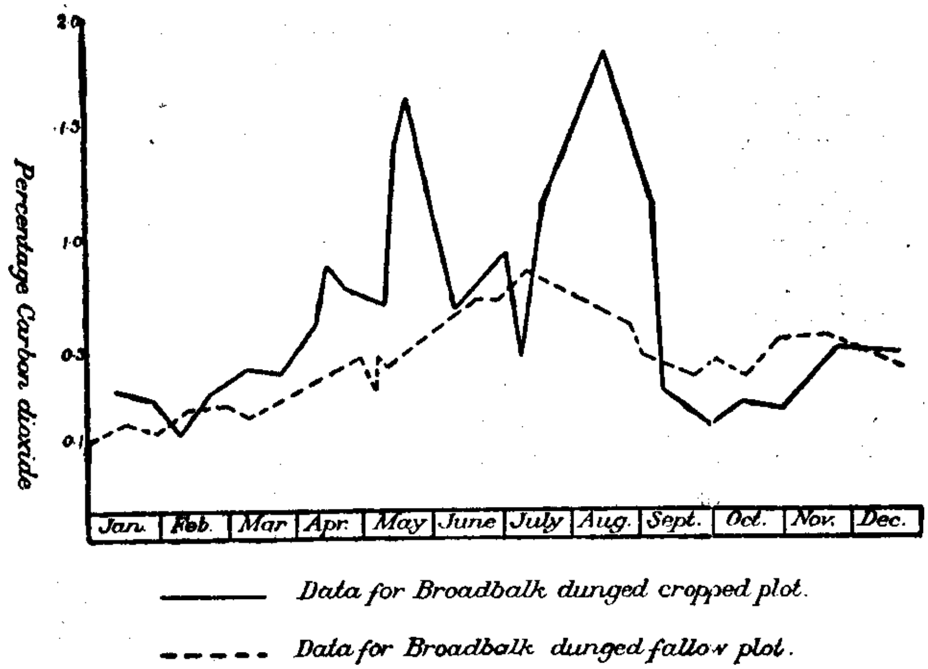

Fig 6.—Percentage of carbon dioxide in the soil air of dunged fallow and of dunged cropped land.

* Russell, E. J., and Appleyard, A., *Jour. of Agr. Sc.*, VIII, p. 385, 1917.

During the rapid growth of the wheat crop in May and during the whole of the ripening period in August there is a great outpouring of carbon dioxide. This is produced at the expense of the oxygen in the soil air. It is easy to understand the great production of carbon dioxide in May. This is associated with the intense biological activity in progress in the soil at this period. It is not so easy to understand why so much oxygen is required during ripening and why so much carbon dioxide is produced. In India, experience teaches us that crops never ripen properly if the soil-aeration is interfered with during this period. A part of the explanation is probably to be found in the fact that the fine roots begin to die and decay after the flowering period but this does not explain why the crop will not ripen unless air is supplied. The changes in the soil air during the life of the crop have so far not been investigated in India. A splendid field for applied research lies untouched which is bound to yield a rich harvest of results.

IV.—Some other aspects of soil-aeration.

It follows that if soil-aeration is a growth factor, aeration must influence the distribution of plants * and prove to be of importance in ecological studies. Attention is now being paid to this aspect of the subject and results are beginning to appear. In the United States, Professor Cannon of the Desert Laboratory in Arizona and Professor Free of the Johns Hopkins University find that an inhibition of root growth is caused in numerous plants by a decreased amount of oxygen in the soil atmosphere†. The poor conditions of soil-aeration are correlated with the absence of vegetation in the dry lakes of desert basins and the zonation of vegetation around these basins is possibly in correlation with the different soil-aeration requirements of the plants involved. Professor Cannon intends to visit India and to pursue his studies in this country.

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* The distribution of gram in India is correlated with soil-aeration. See *Agr. Jour. of India*, Science Congress Number, p. 20, 1917.

† Cannon, W. A., and Free, E. E., *Jour. of Ecology*, V, p. 127, 1917.

In India, also, Mr. Hole has shown that soil-aeration is an important factor influencing the distribution of woodlands and grasslands. As regards the general importance of soil-aeration in Indian forestry, Mr. Hole has kindly promised to place his views before the Congress.

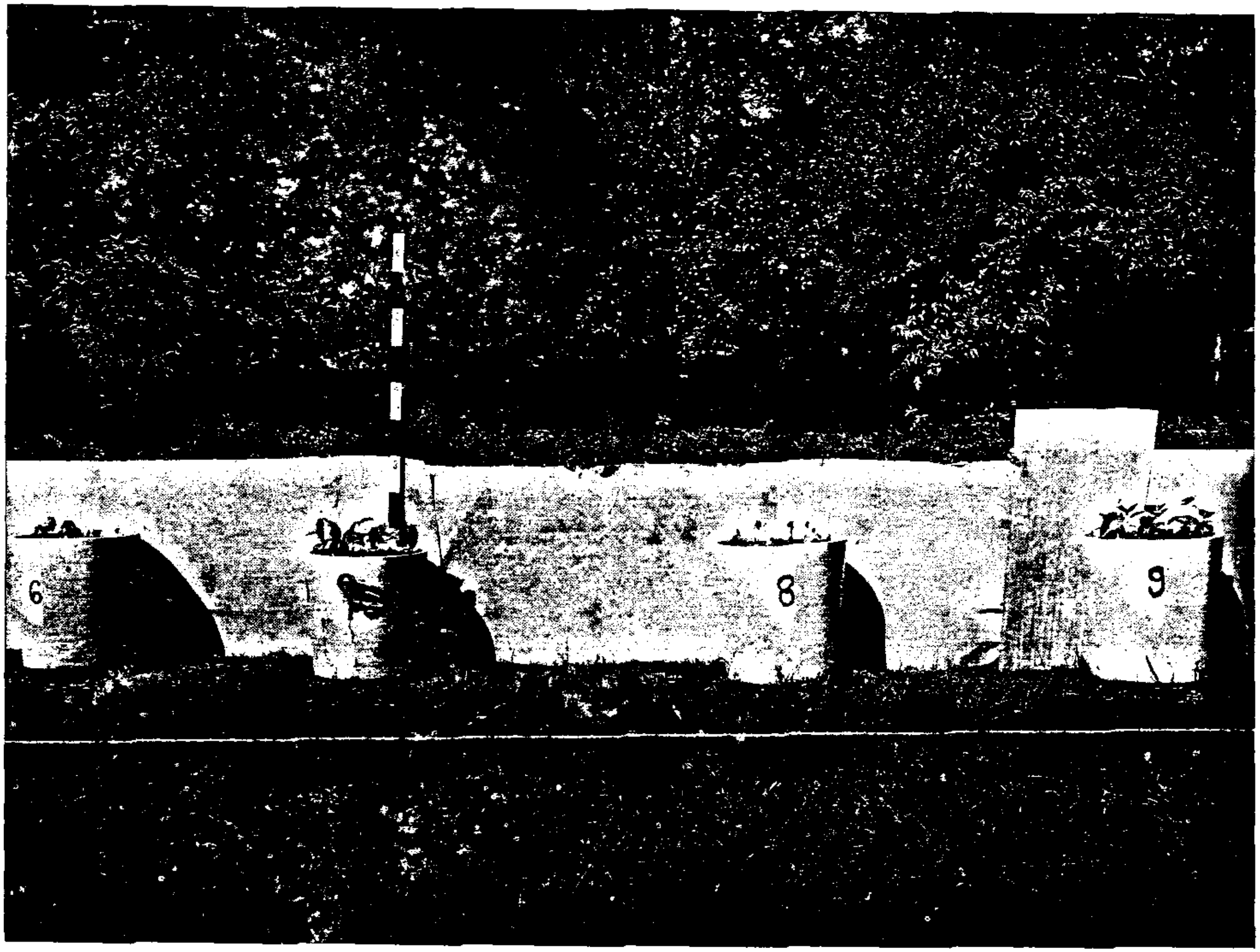
PART II—WITH SPECIAL REFERENCE TO FORESTRY.

1. Mr. Howard has just emphasized the importance of soil-aeration in Indian agriculture and I hope to convince you that it is no less important in Indian forestry.

2. As we frequently have great difficulty in quickly establishing a vigorous growth of seedlings in our valuable Sal (*Shorea robusta*) forests, a study of the factors influencing germination and the development of seedlings was commenced at Dehra Dun in 1909. Preliminary pot experiments carried out in 1909-10 showed that whereas it was practically impossible to injure Sal seed or seedlings by watering in sand, into and through which water percolated rapidly, germination could be materially reduced and the seedlings rapidly rendered unhealthy in water-retaining loam and leaf-mould by keeping the soil constantly moist. It was immaterial whether this moist condition was produced by the addition of water to the soil or by diminishing the loss of water from the soil through evaporation or percolation. The injurious action was most severe in the leaf-mould which contained considerably more organic matter than the loam.* Similar results were subsequently obtained with loam taken from a local Sal forest.† In the latter soil the injurious action can be strikingly demonstrated by growing the plants in non-porous glazed pots, the drainage holes at the base of which are subsequently closed by corks, when the seedlings are well established. In such cases, while evaporation can take place freely from the surface of the soil, no evaporation is possible from the sides of the pots and the water falling on the soil surface accumulates at the base of the pot, thus forming an artificial water-table at the base of the pot.

* *Indian Forest Records*, *V.* 4, Part I, pp. 17, 19 (1914).

† *Loc. cit.*, p 30.



Photograph taken 20th September, 1915, showing Sal seedlings growing in Sal-forest loam.
Note the healthy growth in the uncorked pots 7 and 9 as compared with that in pots 6 and 8 which were corked on 30th July, 1915.

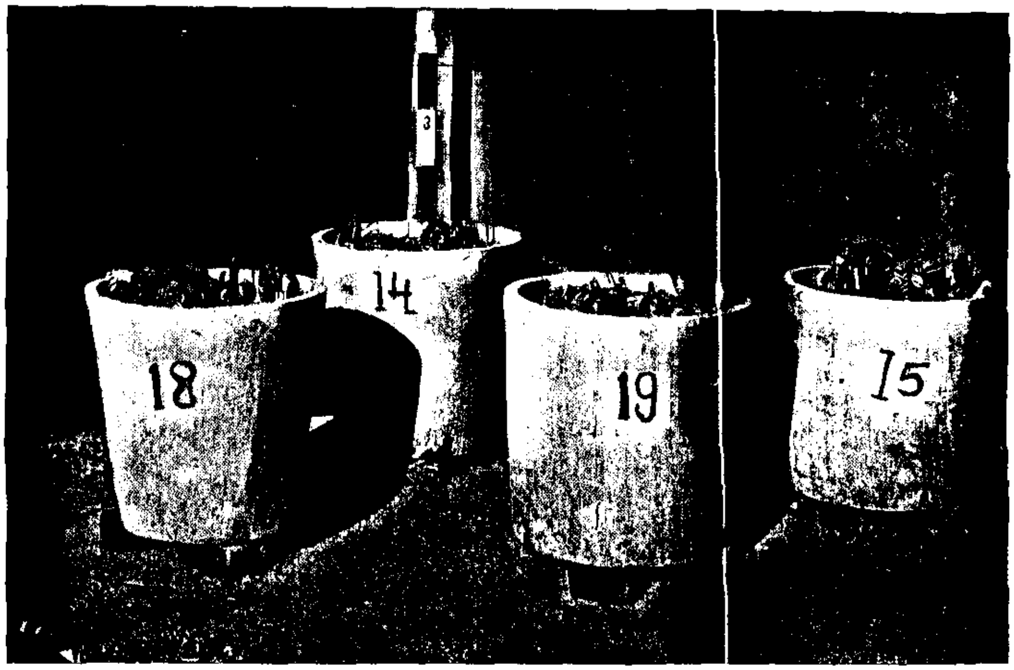


Fig. 1. Several of the Sal seedlings in pots 14 and 19 have shed their leaves as a result of placing dead Sal leaves on the surface of the soil. In pots 15 and 18 to which no dead leaves were added the seedlings are quite healthy. Photograph taken $3\frac{1}{2}$ months after the dead leaves were added.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Photograph of the pots shown in Fig. 1. above, taken one month later. Nearly all the seedlings in pots 14 and 19 have now shed their leaves.

In such cases, when the pots are placed in full sunlight in the open and supplied only with the local rainfall, the seedlings begin to get unhealthy in about ten days and, unless the conditions are altered, eventually die.

Plate 9 shows Sal seedlings growing under these conditions, pots 7 and 9 being uncorked while 6 and 8 have been corked for 52 days. Previous to corking, the number of healthy plants in 7 and 9 was exactly the same as that in 6 and 8. Note the healthy plants in 7 and 9 as compared with those in 6 and 8.* Similar results can, however, be produced by a procedure which to some extent is the reverse of the above, *viz.*, by opening the drainage holes at the base of the pots and then retarding evaporation from the upper soil surface by covering it with a layer of dead leaves.

For the purpose of this experiment seed is sown as before in the glazed pots, the drainage holes at the base of which are left open. When healthy seedlings have been thoroughly established, the surface of the soil in some pots is covered with a layer of dead Sal leaves while no such covering is placed in the control pots. If the soil is then kept moist in all the pots, either by artificial watering or natural rainfall, the seedlings in the pots with dead leaves soon become unhealthy. Plate 10, Fig. 1, shows examples of such plants, 14 and 19 are pots with dead leaves on the surface of the soil while 15 and 18 are pots with no dead leaves. When the dead leaves were placed in position there were 39 healthy plants in the former and 37 in the latter. The photograph was taken 3½ months afterwards, and it will be seen that a number of the plants in the former have shed their leaves. Plate 10, Fig. 2, shows the same plants a month later when nearly all the plants in pots 14 and 19 had shed their leaves. It is interesting to note that if the pots are filled with sand instead of forest loam no injurious effect is produced by the dead leaves. Plate 11, Fig. 1, shows Sal seedlings growing in sand, pot 23 has dead leaves on the surface while pot 22 has no dead leaves. This photograph was taken 3½ months after the leaves were placed in position and

* *Indian Forest Records*, *V.* 4, Part III, p. 90 (1916).

no injurious effect had been produced. In these experiments the layer of dead leaves was six leaves thick which is roughly equivalent to the annual leaf-fall in a well stocked natural forest.

3. Simultaneously with these pot experiments, a series of experiments have been carried out in the Dehra Dun Sal forests. These have shown that, whereas in the shade of the forest germination and seedling development during the rains is uniformly poor, even when the soil-covering of dead leaves is removed and the soil dug, excellent seedling growth can be obtained if the trees are felled in narrow strips or small patches and the seed then sown in the clearings where the soil is exposed to the sun and air. In the former case the soil invariably contained more water and organic matter than in the latter and the unhealthy seedlings invariably showed more or less extensive rotting of the roots. That the injurious agent is here a soil factor and not deficient light is clearly shown by the fact that if pots containing sand are placed in the shade of the forest healthy seedlings with well-developed roots can be produced in them without difficulty. Plate 12, Fig. 2, shows the development of Sal seedlings in a cleared patch 60 ft. in diameter and Plate 12, Fig. 1, shows the corresponding development in the shade of the adjacent forest, respectively. In both cases the seedlings are two years old.*

4. In all the experiments noted above, both in the pot cultures and in the forest, the symptoms shown by the unhealthy seedlings are the same. The first sign of disease is seen in the blackening and death of the tender root tips and rootlets the damage then spreading, unless the conditions are ameliorated, until the entire root-system becomes black and rotten. It is significant that above ground the seedlings may appear quite healthy with green leaves when a number of the deeper roots are dead and rotten. This appears clearly to indicate that the injurious agent is a soil factor and the symptoms convey the impression of a localised poisonous action rather than of a general starvation effect due to lack of essential food materials. Above ground the first sign of trouble is seen in the leaves turning pale and

* *Indian Forest Records*, V. 4, Part II (1916).

Fig. 1. Photograph of healthy Sal seedlings growing in sand, taken $3\frac{1}{2}$ months after a layer of dead Sal leaves had been placed on the surface of the soil in pot 23. No dead leaves were added to pot 22. No injurious effect has been produced by the dead leaves.

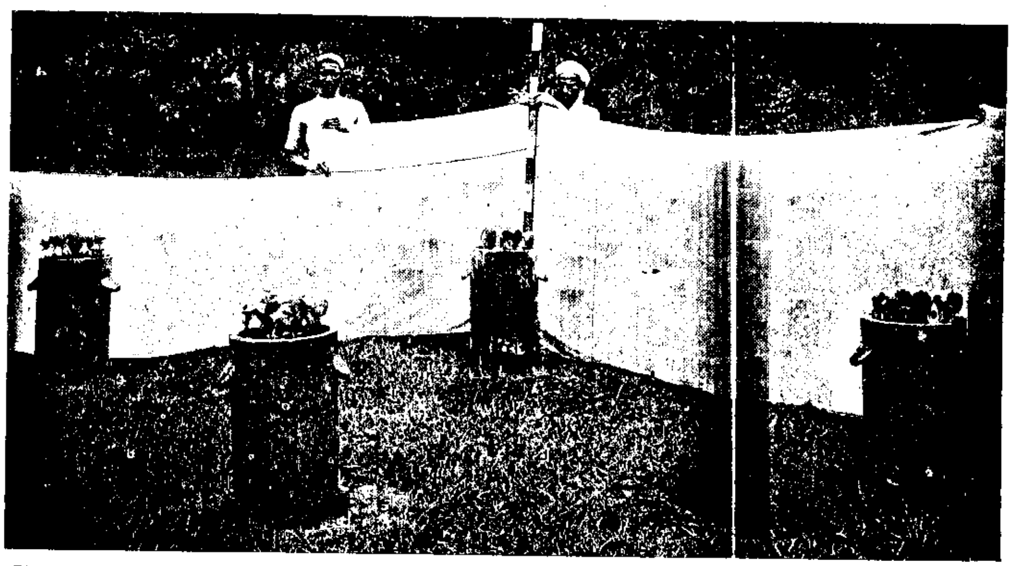


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Photograph of Sal seedlings taken 13 days after the basal drainage holes had been corked in the two pots on the right. In these pots the seedlings are showing the first signs of trouble from bad soil-aeration, the leaves hanging vertically downwards. In the two pots on the left which were not corked the seedlings are healthy with leaves horizontally extended.

Fig. 1. Forest shade plot V. Photograph taken 20th July, 1915. Note the appearance of the 2-years-old seedlings surviving in the plot.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Forest Plot IV. An area 60 ft. in diameter was here clear-felled in May, 1913. The photograph was taken on 20th, July, 1915. Note the vigorous 2-years-old seedlings surviving in the plot.

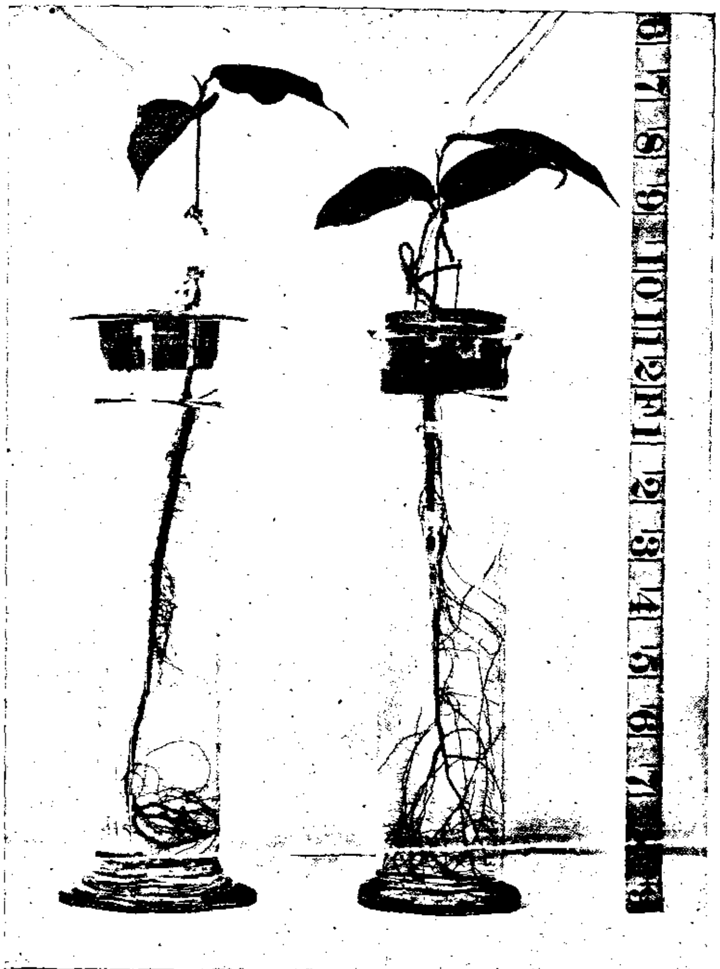


Fig. 1. Sal seedlings which have been growing in a water-culture solution for 4 months and which show a vigorous development of healthy roots, especially near the apex.

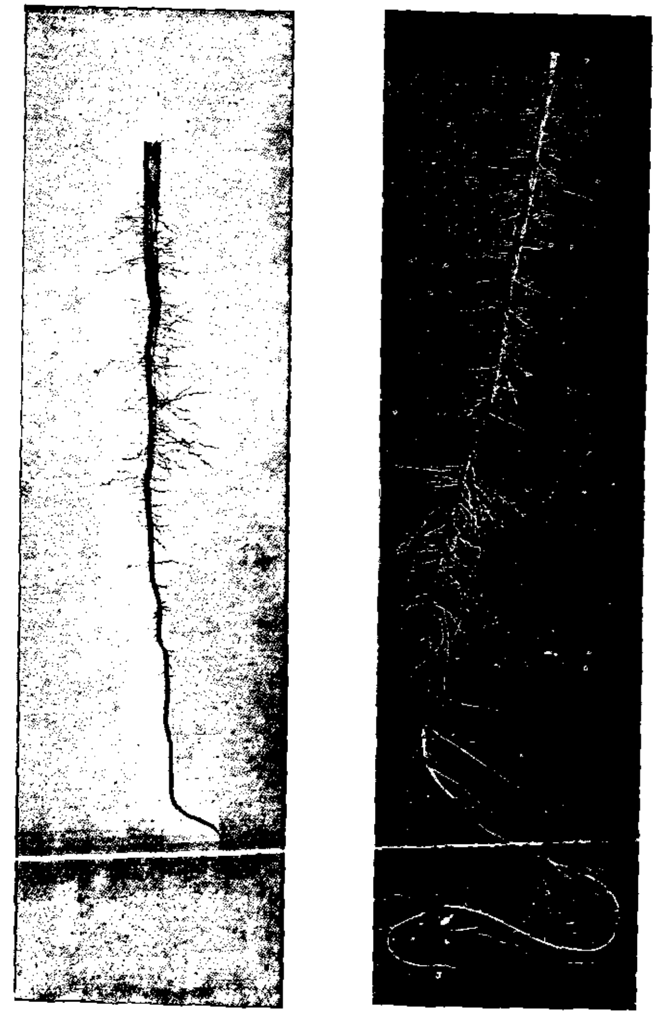


Fig. 2. Showing the root-systems of two Sal seedlings which have been grown in water-culture for 19 days. The one on the right is healthy, showing numerous healthy young roots, and was grown in an aerated solution, while the one on the left has been gassed for 2 minutes daily, the concentration finally attained being 600 Mg. Co_2 per litre of water. In this case the root is dead at the apex and there are no healthy young roots.

hanging vertically downwards instead of remaining horizontally extended. Plate 11, Fig. 2, shows healthy seedlings in the two pots on the left and, in two pots on the right, those showing the first signs of trouble from bad soil-aeration, 13 days after the pots had been corked. The leaves eventually turn brown and drop off. Organisms such as bacteria and fungi are usually absent from the diseased roots at first but may invade the damaged tissue later. It must be noted that the injurious factor may and indeed usually does cause severe damage in a soil which, although being moist, is still far from being in the condition usually associated with the term "water-logged." Experiment has shown that 100 per cent of Sal seedlings may be killed or seriously damaged by this factor when no water is standing on the surface of the soil and when there is a considerable water-free air-space near the roots. Again, although a moist condition of the soil undoubtedly increases the injurious action, it can be easily shown by water-culture experiments that water in itself cannot be the injurious factor. In Plate 13, Fig. 1, are seen Sal seedlings which have been growing in a water-culture solution for four months and which show a vigorous development of healthy roots especially near the apex. As a general rule, no difficulty is experienced in growing healthy seedlings in this way when air is allowed access to the culture solutions.

5. In 1915, an experiment carried out at Dehra Dun showed that when water was held in contact with the Sal forest loam mentioned above in glazed non-porous pots it became heavily charged with CO_2 and impoverished as regards its supply of dissolved oxygen. In 1916, a further experiment showed that when rain-water, with an initial content of 1 milligram CO_2 and 7 milligrams oxygen per litre, was held in contact with this soil in glazed non-porous pots which were placed in full sunlight in the open, the CO_2 rose to from 60—70 milligrams in two days while the oxygen fell to 1 milligram. After 28 days the CO_2 rose to 230 milligrams. These changes took place in soil in which no plants were growing and were, therefore, apparently due chiefly to the activity of the living organisms in the soil. The diagram given on the next page indicates the change in the

dissolved gases observed in rain-water which was kept in contact with this soil for 19 days in corked glazed pots which were placed in the shade and in which Sal seedlings were growing. In this case, the water added to the pots had an initial content of 4·8 milligrams oxygen and 5 milligrams CO_2 and the diagram shows that in 19 days the CO_2 had risen to 163 milligrams, this increase being correlated with a fall in the oxygen content which, at the end of the period, was 1·2 milligrams per litre. At the close of this period, in 95 per cent. of the Sal seedlings growing in these pots the roots were completely dead and rotten.

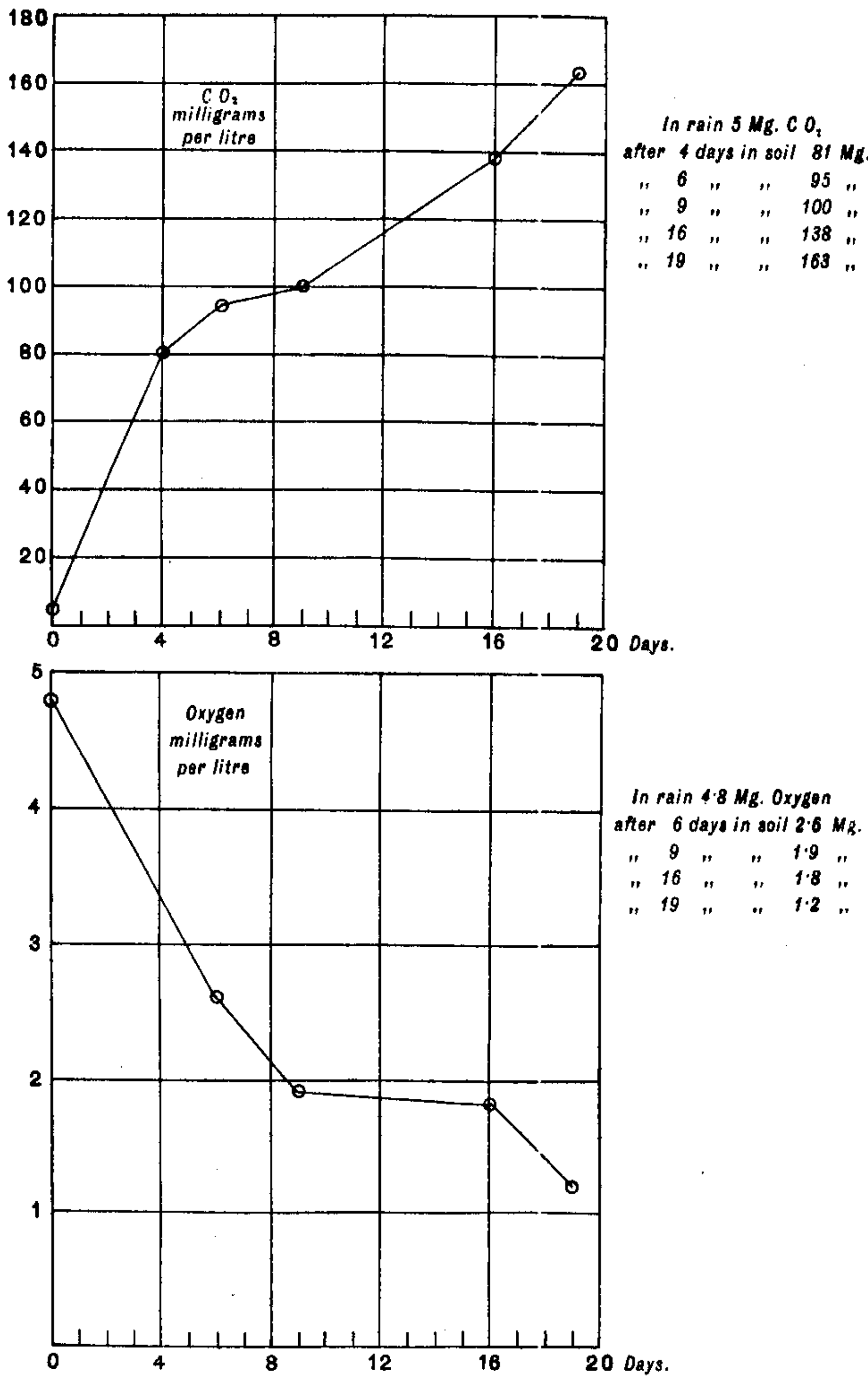


Diagram showing changes in the dissolved gases found in rain water which was held in contact with Sal-forest loam for 19 days in corked pots.

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All the figures quoted above represent the quantities of these gases which were found dissolved in the percolation water drawn off from the base of the pots. So far as our experiments, therefore, have gone at present they show that the injurious action on the roots of Sal seedlings is associated with a very small oxygen and high carbon dioxide supply. That a deficiency of oxygen may be injurious to roots is usually accepted by physiologists and is indicated by such water-culture experiments as the one quoted by Mr. Howard. The effect of this factor on the roots of Sal seedlings still requires to be investigated.

The effect of various quantities of CO_2 gas on these roots, however, has been tested by us, simultaneously with the pot experiments mentioned above, by growing the seedlings in water-cultures and bubbling the gas through the culture solutions.

So far as these water-culture experiments have gone at present they show that, when the concentration of the gas reaches roughly 500 milligrams per litre and above, the delicate root-tips and rootlets of vigorous Sal seedlings are blackened and killed and the production of new roots is inhibited, the appearance of the damaged roots resembling that of those found in badly aerated soil. Plate 13, Fig. 2, shows the root system of two Sal seedlings which have been grown in water-culture for 19 days. The one on the right is healthy and was grown in an aerated solution, while the one on the left has been gassed for two minutes daily, the concentration finally attained being 600 milligrams CO_2 per litre of water.

The fact that the concentration required to produce this injurious effect in water-cultures is considerably higher than that which exists in the percolation water taken from pots in which Sal seedlings are suffering severely from the injurious factor would appear, at first sight, to put CO_2 out of count as a possible cause. It is believed, however, that this conclusion is not yet justified. During these culture experiments it was noticed that those roots which happened to be near the exit of the gas tube were blackened and killed when those further away still remained uninjured and also that healthy roots were often produced near the upper surface of the solution which was in contact with the air and farthest removed

from the gas tube mouth while the roots deeper down were obviously unhealthy. It is believed that differences in concentration of this kind are even more marked in the soil than in water-cultures such as those dealt with above. It thus seems possible that extensive damage may be done to the roots when the concentration of CO_2 in the mass of the percolation water filling the pore space in the soil is too weak to cause injury. It must also be remembered that in badly aerated soil there are apparently always two injurious actions at work together, *viz.*, a deficiency of oxygen and an excess of CO_2 and it is probable that the injurious action of CO_2 depends largely on the quantity of oxygen available.*

There is reason to believe that a deficiency of oxygen is in itself injurious to the roots while such a deficiency appears to be invariably correlated with an accumulation of CO_2 and possibly also of other poisonous substances. At present, therefore, it seems probable that the most reliable indication of the conditions of aeration in the soil will be obtained by determining the quantity of oxygen and CO_2 existing in the soil and that we may define a badly aerated soil as one in which there is a deficiency of oxygen and an excess of CO_2.

To determine whether this is correct or not, further extensive experiments are required in which determinations of these gases should be correlated with careful observations on the root growth. In forestry it is important that we should be able to determine quickly when the conditions of soil-aeration are becoming unsuitable for the healthy development of our trees so that the treatment may be altered without undue loss of time and before serious damage has been done. Analysis of the soil gases at present promises to be the best means of effecting this and it is with the hope that the attention of some of those eminent chemists who are present here to-day may be attracted to the subject and that they will help us to elaborate easy and practical methods of soil-gas

* Thus Kidd has shown that, with 5 per cent oxygen, 9—12 per cent. carbon dioxide inhibits the germination of seeds, whereas, with 20 per cent. oxygen, 20—25 per cent. carbon dioxide was required to produce inhibition with a temperature of 17° C. (*Ann. Bot., XXXI, p.* 457, 1917.)

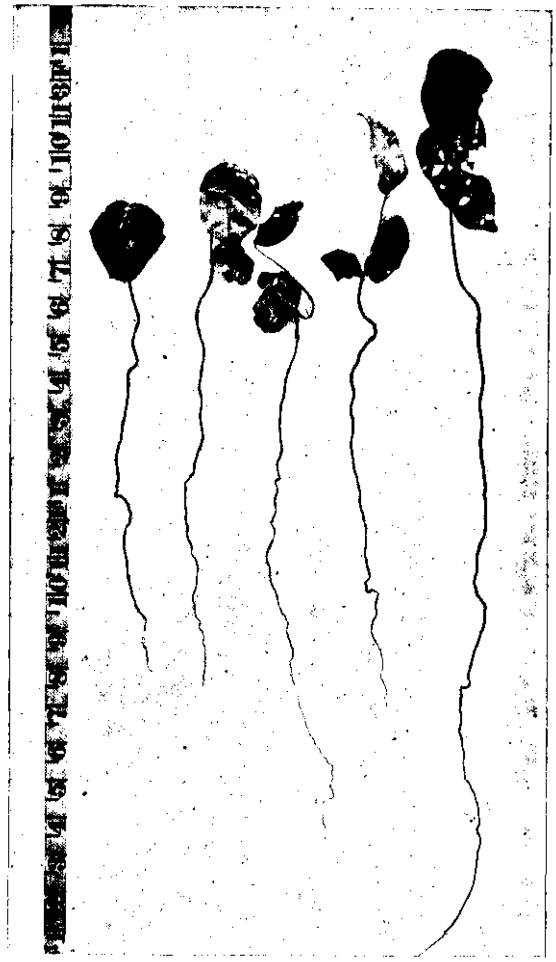

Fig. 1.

Fig. 2.

Showing the root-development of Sal seedlings at the end of the first rains ; in fig. 1, plants which have been grown in porous well-aerated loam and, in fig. 2, plants which have been grown in dense badly aerated loam.

Note the respective root-growth in the two cases.

analysis suitable for application in the forests that the present paper has been written.

6. From what has been said above it will be seen that soil-aeration apparently depends chiefly on :—

(1) The amount of water in the soil.

(2) The amount of organic matter in the soil.

(3) The number and kind of soil organisms.

(4) The rate at which currents of air, or water with oxygen in solution, penetrate into and percolate through the soil.

In the Sal forest loam used in the pot experiments mentioned above, bad aeration appears to depend chiefly on the first three of these factors, but experiments have shown that soil texture and rate of percolation are no less important. Plate 14, Figs. 1 and 2, show the growth of Sal seedlings of the same age in porous and dense loam respectively. In the latter the time required for ½ inch of water to penetrate below the surface was 750 seconds, whereas in the former it was 46 seconds. Note the respective root growth of the seedlings in the two cases. In dense soil germination is reduced, more seedlings die during the rains of bad aeration and of drought during the dry season owing to poor root development.

7. It is important to note that the various agencies which influence soil-aeration can be controlled to a considerable extent by ordinary forest operations apart from the obvious but expensive methods of draining and soil cultivation. Thus the quantity of water, of soil organisms and of organic matter can be regulated by varying the shade and quantity of dead leaves added to the soil and also by the controlled use of fire. Texture is also influenced by the amount of organic matter in the soil and also by such factors as the grazing of cattle, both of which are capable of regulation. In some cases the temporary encouragement of the growth of certain grasses and other herbs, the roots of which are much sought after by such forest cultivators as rats and pigs, is an important factor in improving soil texture. The felling of trees and the subsequent decay of the subterranean roots is also an important

factor in influencing soil-aeration, a point which has recently been emphasized by Mr. Howard. There is thus good reason to believe that, provided we can elaborate a method, by soil-gas analysis or otherwise, of quickly and accurately identifying a condition of bad soil-aeration, we shall, at any rate in many cases, be able to apply the necessary remedy.

8. As regards the general importance of soil-aeration in Indian forestry, it must, I think, be accepted that this factor is of primary importance in the case of the Sal, the only species which, up to date, has been studied in any detail in this connection and regarding which our knowledge is still very imperfect. In the moist forests of Dehra Dun it has been shown that the establishment of seedling growth depends primarily on this factor and Mr. R. S. Troup has recently shown that this is also the case in the moist Sal forests of Bengal and Assam.* In the latter case it is interesting to note that subjecting the forest to fires is now said to be improving the seedling growth. Apart from the question of the establishment of seedlings, Mr. R. G. Marriott has recently ascribed the poor development of older trees to this factor and suggests that, owing to it, the trees may practically cease to grow during the rains which ought to be the period of most vigorous growth.†

Finally, it is interesting to note that, although the Sal root-fungus *Polyporus Shoreæ* is widely distributed throughout the Sal forests of India, so far as is known at present, it only causes serious damage in those wet forests of Bengal and Assam in which the conditions of soil-aeration are known to be particularly unfavourable. Bad soil-aeration by producing a diseased and sickly condition in the roots may be a factor of great importance in facilitating the attacks of injurious root-fungi of this class. It is interesting to note from an œcological point of view that the natural distribution of the Sal appears to be regulated largely by this factor. Thus good Sal forests are not known to occur on really wet soils unless these soils consist chiefly of gravel and sand. On loam the best Sal forests are limited, so far as we know at present, to those

* *Note on the Forests of the Duars, Simla,* 1915, *p.* 6.

† *Indian Forester, Vol. XLIII, p.* 444.

areas which are well drained and where the soil texture is good. These facts of distribution accord precisely with the results of the Dehra Dun pot experiments which have shown that whereas on well-aerated sand it is practically impossible to give too much water to Sal seedlings, the latter are very susceptible to injury by bad soil-aeration in loam.*

There is good reason for believing that several other species of our most valuable Indian trees are no less susceptible than Sal to the influence of soil-aeration and, speaking generally, there can be little doubt that this factor is of great importance in Indian forestry whether considered with reference to its effect on the healthy growth and development of seedlings and trees or its possible connection with injurious diseases or, finally, with regard to its œcological importance in influencing the distribution of species and types of vegetation.

9. Before leaving this subject I venture to suggest that the following, which of recent years have attracted much attention, may possibly be found to be primarily cases of bad soil-aeration. Pickering's experiments at Woburn have demonstrated the injurious effect of grass on fruit trees which has been attributed to the presence in the soil of a toxin which is either produced directly by the grass roots or from the organic remains of such plants. A dense growth of grass is correlated with an accumulation of dead roots, leaves and other débris in the surface soil which would ordinarily encourage the rapid reproduction of the soil organisms engaged in the decomposition of organic matter. We should naturally expect that rain-water, percolating through such a layer of grass, would tend to be deprived of the oxygen by the numerous living grass roots and soil organisms and would become heavily charged with CO_2. Pickering notes that when such "toxic" water is exposed to the air, for 24 hours, its toxic property is found to have entirely disappeared.† Exposure to the air would tend

* That soil-aeration influences the distribution of types of vegetation other than Sal forest is indicated in *Indian Forest Memoirs, Bot., Vol. I*, 1, *p.* 46 (1911), and in *Indian Forester*, XLII, p. 344 (1916).

† *Annals of Botany*, 31, *p.* 184 (1917).

to make good a deficiency of oxygen and to dissipate an accumulation of CO_2 by diffusion.*

The work of Russell and others at Rothamsted has shown that in soils which are kept moist, warm, and richly supplied with organic matter plant growth is frequently unsatisfactory and this is correlated with an exceptional development of the larger soil organisms such as protozoa. May not this unusual development of large organisms be responsible for a deficiency of oxygen and an accumulation of carbon dioxide, and thus for a condition of bad soil-aeration?

10. In conclusion, although I have enjoyed the privilege of putting these points before the members of the Science Congress it must not be thought that I, personally, can claim the credit for such results as have already been obtained. For the recognition of the importance of soil-aeration in practical forestry we are indebted to the careful observations of forest officers like Messrs. R. S. Troup and R. G. Marriott, while as regards the experimental work carried out at Dehra Dun the lion's share, including all the chemical work, has been done by Mr. Puran Singh, our Chemical Adviser, and his assistant, Mr. T. P. Ghose, who have carried this through under great difficulties and under constant heavy pressure from other duties.

FORESTRY IN LOWER BURMA

FORESTRY IN LOWER BURMA.

BY H. W. A. WATSON, I.F.S.

Referring specially to Zigôn division, I consider that Forestry in Lower Burma suffers from four grave handicaps :—

(1) The so-called Selection system.

(2) The outlying plains reserves.

(3) The lack of system under which Improvement fellings are carried out.

(4) The dread of the Kyathaung bamboo flowering.

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* Mr. Howard made a similar suggestion in 1915, see *Soil Ventilation, Pusa Bulletin No.* 52, pp. 22, 23.

2. To take these seriatim :—

The so-called Selection system was evolved at a time when the staff was inadequate for supervision. It is admittedly rough and inadequate, and it is hard to realize why to date it has not been replaced by a more rational system. Where only certain species in a mixed forest are saleable, any system of selection which bears only on one, or possibly more, species forming a small percentage of the crop, must logically result in a great reduction in the stock of the species exploited. The counterpoise was to have been Improvement fellings ; but so far these have been carried out unsystematically and, apart from this, have failed to keep pace with extraction. Of late years, the introduction of the Uniform method has been under consideration ; but our moves in this direction have been desultory and on the whole negligible in results.

3. The comparatively small outlying patches of plains reserves constitute an embarrassment in that they distract our attention from what should be the primary object, *viz.*, the proper silvicultural management of the large block of Yoma reserves. These plains reserves are situated on land that is eminently suited for permanent cultivation. Their environs are thickly populated and their adequate protection from organized theft is, under existing conditions, almost an impossibility.

The grounds for their maintenance are that the agriculturist must have timber at his door-step. The distance from the railway line to the edge of the Yoma reserves, as yet practically untapped for timber other than teak, is roughly 12 miles. A rational policy for working these plains reserves would be to work them out by coupes during a period of, say 30 years, abandoning each coupe to cultivation as worked out and to put the profits from their disintegration into roads to render the vast resources of the Yoma reserves readily accessible.

4. Improvement fellings have been classified in two grades: "O" fellings for the improvement of the existing stock and "Y" fellings to induce or aid regeneration. Where, as usually is the case, the produce felled is unutilizable and unsaleable the operation is economically unsound.

"O" fellings progress annually by square miles; but, except in rare cases where groups of valuable species are freed, the results are barely worth the paper they are described on. "Y" fellings progress annually by acres (in Zigôn division there have been none so far). Their cumulative effect as compared with the total area of reserves is so fractional as to be almost negligible.

The most striking feature, however, of many Improvement fellings is that they appear to be carried out without any clear object being aimed at. Their general object should be the creation of a homogeneous crop over as large an area as possible. Yet the primary essential to produce this, namely, the careful use beforehand of a preparatory extraction of the saleable species that are overmature or interfering with promising groups is almost invariably omitted. This omission is equally obvious in the case of compartments, that are heavily planted over.

5. Interwoven with the question of Improvement fellings is that of the flowering of the Kyathaung bamboo which is expected to take place in the near future. Theories and orders on the subject of our action in this contingency have been flying round for the past twenty years or more. It is anticipated that the combined results of Providence and our efforts during this flowering will enormously enhance the value of our forests. In fact, we gamble on being able, at a single coup, to accomplish more than could be done by at least a decade of steady endeavour. We disregard the fact that other bamboo species have flowered periodically in the past over many square miles without our having succeeded in gaining any appreciable advantage by the phenomenon. The results from the Kyathaung flowering will probably be likewise and the less we expect from it the better. There is, as a rule, practically no advance growth under Kyathaung and inducing such is hadicapped over *much of the area by a dense growth of seedlings of other species of* bamboo while weeds will spring up as soon as the cover is opened up. Whereas in the case of other bamboos that have flowered gregariously good patches of advance growth were the rule rather than the exception. In short, I think that taking advantage of the Kyathaung flowering is going to be too big a job for us to tackle

and instead of gambling on it, I would favour efforts to progress steadily on more assured lines.

6. A very neglected factor for the improvement of our forests is the 'taungya' cutter. This individual has made up his mind that he must live by cutting down jungle and planting crops in the clearings. At one time his efforts were extensively utilized for making teak plantations; but a policy arose which discouraged the extension of these plantations. The grounds were that we had not the staff to tend them properly. This was a pity as such plantations, if concentrated, are little harder to tend than regeneration induced by Improvement fellings and even inadequately tended, the fact remains that they replace a useless with a useful growth. The effort to get a high percentage of success has been the curse of plantations in the past.

The controlled 'taungya' cutter felling and burning the useless species to produce a field crop mixed with teak is economically accomplishing more than results from our "Y" fellings which, producing less teak and no field crop, make no greater annual progress in area than would concentrated 'taungya' plantations.

It may be argued that the 'taungya' cutter may raise difficulties about our control. A little careful cultivation of the individual combined with where possible a little pressure will accomplish much in dealing with him. There is no getting over the fact that our policy starting from the year 1897 of reducing 'taungya' plantations did much to discourage the 'taungya' cutter and was in many cases grossly unfair to him. He had planted for us for a number of years and we dropped him without warning when the administration imagined it suited them to change the policy. We had even induced some of the Pegu Yoma Karens—a conservative and obstinate race—to plant for us and we dropped them without consideration. However we may revile the 'taungya' cutter, the fact remains that in dealing with him we have not been conciliatory or in many cases even fair. Of recent years (the policy at the time the Pegu Yoma reserves were formed was otherwise), we have consistently treated him as an enemy.

7. This preamble leads up to my suggestions for our future silvicultural policy. Summarized these are :—

(i) Classify our forests into zones for regeneration purposes as follows :—

(*a*) Accessible to the extraction of (i) the heavier timbers or (ii) bamboos.

(*b*) That can be made accessible to such extraction within the time required to regenerate (*a*).

(*c*) That although at present inaccessible to extraction, can be planted up by the agency of 'taungya' cutting villages in the vicinity.

(*d*) Other areas.

(ii) Treat Burma as a whole and colour in zones (*a*) and (*c*) on our maps as our first period under the Uniform method.

Regenerate (*a*) by Improvement fellings combined with planting, if necessary after the removal of the marketable species.

Regenerate (*c*) by the 'taungya' method.

The areas covered by (*a*) and (*c*) in the whole of Burma will probably be so great that the question of regenerating zones (*b*) and (*d*) need hardly trouble the present generation. In divisions where such areas are wanting they could doubtless be created by improving communications and the establishment of forest villages. It is thought that in such divisions money should be put into communications rather than into Improvement fellings; but it seems best to treat Burma as a whole and, if funds are inadequate, scrap temporarily inacessible divisions rather than diffuse our efforts.

(iii) Limit Improvement fellings outside the areas under regeneration to the destruction of creepers and ficus except in the rare cases where we can free groups of young stock ; but such work should be considered absolutely secondary to work to be done under (ii).

At the same time keep always in view the question of bringing zones (*b*) and (*d*) into zones (*a*) and (*c*).

In brief, cease or modify our pres ent irresponsible policy of wasteful extermination by so-called Improvement fellings of species that we consider useless in favour of a policy fo· utilizing such species as far as possible in accessible areas, as timber by concentrated extraction and in the less accessible areas, as nutriment for crops by concentrated regeneration on the 'taungya' method.

The Uniform system with regeneration on the French "Quartier bleu" system is indicated.

NOTE ON JUNGLEWOOD SHINGLES.

BY J. D. HAMILTON, PROVINCIAL FOREST SERVICE.

Owing to the prevailing exorbitant prices for corrugated iron roofing, an old-time industry of hand-sawn shingles is being somewhat revived at Taungdwingyi, Magwe, Upper Burma. As an all-round roofing material, shingles are superior to corrugated iron in that they make a much cooler roof and may last as long, if not longer. The reasons for corrugated iron having been used in the past more extensively than shingles were :—(1) The comparative ease with which it could always be obtained in local bazaars and erected. (2) The lower cost of a roof made of the inferior kinds of corrugated iron as compared with the Rangoon price of teak shingles—the only real competitor in the market. If shingles and battens could be made readily available to the public at a price to compare with corrugated iron, there can be no doubt that shingles would replace the iron, as the latter must have a ceiling for a dwelling house while a Burman can live under a plain shingle roof without inconvenience. Corrugated iron also does not last well where wood smoke gets to the roof as the acid fumes soon destroy the zinc coating and then rust eats away the iron. Every corrugated iron kitchen roof is evidence of this.

At the present time the cost of corrugated iron is more than double what it was before the war and often cannot be procured

at all. The moment is hence eminently favourable for the introduction of shingles on a large scale to capture the market. And once captured it could be held for years, as it will be a long time before corrugated iron will again be able to appear as a competitor.

2. *Method of sawing shingles by hand at Taungdwingyi.*—Scantlings are cut from the round log so as to have a side of the width of the shingle required (usually 5 inches) and some multiple of $1\frac{1}{8}$ inches for the other side. (The $\frac{1}{8}$ inch is an allowance for saw-cuts and the thickness of two shingles make an inch.) The scantling is then marked out into shingle lengths of 14 or 15 inches, as required, and the first length is sawn into as many one inch planks as the scantling will yield, producing a comb-like division of the wood. Each plank or tooth of the comb is then sawn diagonally along its length into halves having a $\frac{1}{4}$ inch thickness at one end and $\frac{3}{4}$ at the other, *i.e.*, into two shingles. After each plank or tooth has been so treated, all the shingles are sawn off at right angles to the scantling and the next length cut into planks and diagonally divided into shingles. The sawing throughout is done on the saw-pit in the usual manner by two men, and it is estimated that they turn out frcm 80 to 100 shingles per day. The sawing rate for all soft woods used is Rs. 7 per thousand. The shingles so sawn are of a uniform quality and about as regular as those turned out by machinery. The selling price of the shingles at Taungdwingyi is Rs. 22 per thousand. This refers to soft woods only. Teak shingles stand in another class altogether and deserve, and may receive, separate treatment. The junglewoods used for shingles are *kyunbo* (Premna pyramidata), weight 40 lbs. per c. ft., *kuthan* (Hymenodictyon excelsum), weight 30 lbs. per c. ft., *letpan* and *didu* (Bombax malabaricum and insigne), weight 28 lbs. per c. ft.

3. Shingles before use are boiled in a mixture of earth-oil and water in a proportion of about two to one for at least half an hour. An iron cauldron is used for the purpose and the addition of the water is said to minimize the risk from fire.

Such shingles properly treated with earth-oil last in Taungdwingyi from twenty-five to thirty years. There is much local

evidence of this. The woods *kyunbo, kuthan, letpan* and *didu* are not in themselves of a very lasting quality and their longevity in a shingle roof is almost solely due to the amount of earth-oil they absorb during boiling. *Kyunbo* and *kuthan* are somewhat superior to *didu* and *letpan* in that they are not attacked by borers even if not treated with earth-oil ; but *didu* and *letpan*, on the other hand, seem capable of taking up more oil and so give equally good results when used as shingles. The woods used as battens in connection with the shingles are *kyunbo, kuthan, in* and one or two other light woods which are not attacked by borers. *Didu* and *letpan* could of course be used if boiled in earth-oil the same as shingles, before use.

4. *Cost of roofing* 100 *sq. ft. with shingles.*

	Rs. a. p.	Rs. a. p.
500 shingles at Rs. 22 per 1,000 shingles	11 0 0	
Earth-oil for 500 shingles ...	1 4 0	
240 r. ft. battens 2″ × 1″ at Rs. 2 per 100 ft.	4 12 0	
Labour	2 0 0 =	19 0 0

Cost of roofing 100 *sq. ft. with corrugated iron sheets.*

	Rs. a. p.	Rs. a. p.
6′ × 2′ at Rs. 100 per 100 sheets (minimum pre-war rate), ten corrugated iron sheets allowing 3″ for overlap ...	10 0 0	
50 r. ft. battens 3″ × 2″ ...	3 8 0	
Labour	1 8 0 =	15 0 0

In order, however, to make a corrugated iron roof habitable some form of ceiling is necessary. The cheapest ceiling in use is made of heavy bamboo matting attached to the rafters by means of laths.

Cost of 100 *sq. ft. of ceiling.*

		Rs. a. p.	Rs. a. p.
Battens 50 r. ft., $2\frac{1}{2}'' \times 2''$	...	2 12 0	
Laths $3'' \times \frac{1}{2}''$, 100 r. ft.	...	1 12 0	
Matting ...	...	2 0 0	
Nails	...	0 8 0	
Labour	...	1 8 0 =	8 8 0

Cost of 100 sq. ft. corrugated iron roof with mat ceiling comes to Rs. 23-8-0 as against Rs. 19 for shingles. And even with the mat ceiling the corrugated iron roof is not so cool as the shingle roof nor does it present nearly such a pleasing appearance. The Burman too prefers the appearance of shingles.

If instead of the mat ceiling we add a plank ceiling, the cost of the ceiling alone comes to Rs. 24 per 100 sq. ft., and this added to the cost of the corrugated iron roof equals Rs. 39.

In these calculations, I have taken the very cheapest grades of corrugated iron at minimum pre-war rates. The same material is now selling at from Rs. 250 to Rs. 350 per hundred sheets at Taungdwingyi and, of course, there are only buyers of odd sheets to repair a former roof or meet some unlooked-for demand. The cost of a corrugated iron roof at the present moment would be about Rs. 39 per 100 sq. ft. without any ceiling. The time is hence eminently favourable to place a cheap and reliable roofing material on the market. But this cannot possibly be done by the local timber trader who has neither the means nor the business capacity to launch out on a large scale. The shingles and battens should be cut by machinery, not so much to lessen the cost of conversion as to increase the outturn and place the roofing material in all bazaars and markets. The shingles and battens should be thoroughly boiled in earth-oil before being sold so as to reduce the purchaser's labour.

I am of opinion that if this were done the demand would outrun the supply.

5. *The actual cost of producing shingles at Taungdwingyi.*—A *kyunbo* log 17 ft. long by 4 ft. 5 in. girth was selected and converted into shingles and battens. The log yielded 480 shingles and 144 r. ft. of 2″ × 1″ battens.

Expenses on the log were—

	Rs.	as.	p.	Rs.	as.	p.
Marking fee	1	0	0			
Royalty	1	0	0			
Felling and logging ...	0	8	0			
Carting to Taungdwingyi ...	4	12	0	7	4	0
Cost of cutting 480 shingles at Rs. 7 per 1,000 ...	3	5	9			
Cost of cutting 144 r. ft. battens at Rs. 10 per 100 battens 18′ × 2″ × 1″ ...	0	12	9	4	2	6
				11	6	6
The sale price of 480 shingles at Rs. 22 per 1,000 ...	10	9	0			
The sale price of eight battens, 18′ × 2″ × 1″ at Rs. 35 per 100	2	12	9	13	5	9
Profit				1	15	3

A large log would give somewhat better results and the average profit may be reckoned at about 20 per cent. on the outlay.

A point, however, which should not be lost sight of is that if the same log instead of being sawn into shingles were to be cut into planks 17′ × 5″ × 1,″ the yield would be 17 planks and 144 r. ft. of 2″ × 1″ battens.

	Rs.	a.	p.	Rs.	a.	p.
Cost of sawing 17 planks at Rs. 15 per 100 ...	2	8	9			
Cost of sawing 144 r. ft. battens at Rs. 10 per 100 battens 18′ × 2″ × 1″ ...	0	12	9	3	5	6
Cost of log as above ...	7	4	0	10	9	6
Value of 17 planks 17′ × 5″ × 1″ at Rs. 75 per 100 ...	12	12	0			
Value of eight battens 18′ × 2″ × 1″ at Rs. 35 per 100	2	12	9	15	8	9
Profit				4	15	3

or nearly 50 per cent. as compared with only 20 per cent. for shingles.

6. It is evident, therefore, that converting logs into shingles is not the most economical way of utilizing timber. But far more shingles can be sold than planks, and the total possible earnings by cutting the former far exceed all possibilities with the latter. The cost of carting (Rs. 12 or more per ton) makes it impossible to develop the industry at Taungdwingyi. It should be started somewhere in the vicinity of a river to permit of logs being brought to the locality in large numbers by water and also permit of the easy distribution of the shingles and battens after conversion. A plentiful and cheap supply of earth-oil would also be a desideratum. But I believe both these conditions are to be met with in this and adjoining divisions. The conversion of the shingles should include the use of both saw-pits and saw benches driven either by a steam or crude oil-engine. The latter for preference, as the earth-oil would be its fuel and no certificated hand would be required as with a steam boiler. The saw-pits would be used to break down the logs from the round to feed the saw benches. Combining hand-saws

and power benches is a much cheaper method than erecting large and expensive machinery in out-of-the-way places to deal directly with large logs in the round.

7. Under the above working conditions, I estimate a working capital as follows:—

	Rs.	a.	p.
Oil-engine of about 25 h.-p. with outfit,	4,500	0	0
Eight wooden saw benches with saws and pulleys	1,600	0	0
Shafting and brackets, etc. ...	700	0	0
Cost of working shed	1,000	0	0
Cost of setting up plant	1,000	0	0
Belting and small tools	500	0	0
Saw sharpening machine ...	200	0	0
Mill stores and spares	300	0	0
Total ...	9,800	0	0

say Rs. 10,000.

This machinery would easily produce 8,000 shingles and enough battens for same (1,072 r. ft.) per day.

For working expenses, duty on timber and the like, a further capital of Rs. 10,000 would be needed. Total capital Rs. 20,000.

8. Cost of producing shingles and battens.

	Rs.	a.	p.
Logging, dragging and rafting *didu* or *letpan* logs per ton	4	0	0
Duty per ton	1	8	0
Cost of converting one ton in the round into shingles and battens including all labour and depreciation on machinery,	7	8	0
Total ...	12	0	0

8. I did not give details of the third item of Rs. 7-8-0 as this would only encumber the note and add little to its value. I may only add that my calculations make it less than this amount and all the saw-mills along the Rangoon Prome Railway line undertake to saw up *pyinkado* timber at rupees ten per ton.

One ton *didu* will yield 1,200 shingles and 360 r. ft. of battens 2″ × 1″.

	Rs.	a.	p.
The cost of the shingles may be taken as Rs. 9 and of the battens as Rs. 3.			
The cost of 1,000 shingles would thus be ...	7	8	0
and of 134 r. ft. of battens to suit ...	1	2	0
	8	10	0
Earth-oil and labour for boiling and bundling	3	8	0
Total cost ...	12	2	0

Now supposing the selling price of 1,000 shingles and 134 r. ft. of battens was fixed at Rs. 20 it would mean a profit of something over 60 per cent. And with shingles at this price, it would only cost Rs. 12 to roof 100 sq. ft., as compared with Rs. 15 for corrugated iron of the flimsiest quality and at the cheapest rate Burma has ever known.

9. The yearly earnings may be reckoned as follows :—

Daily outturn of shingles with necessary battens—Rs. 8,000.

Taking 280 working days for the year, the total output would be 2,240,000 shingles with battens.

Profit per 1,000 shingles = Rs. 7-14-0.

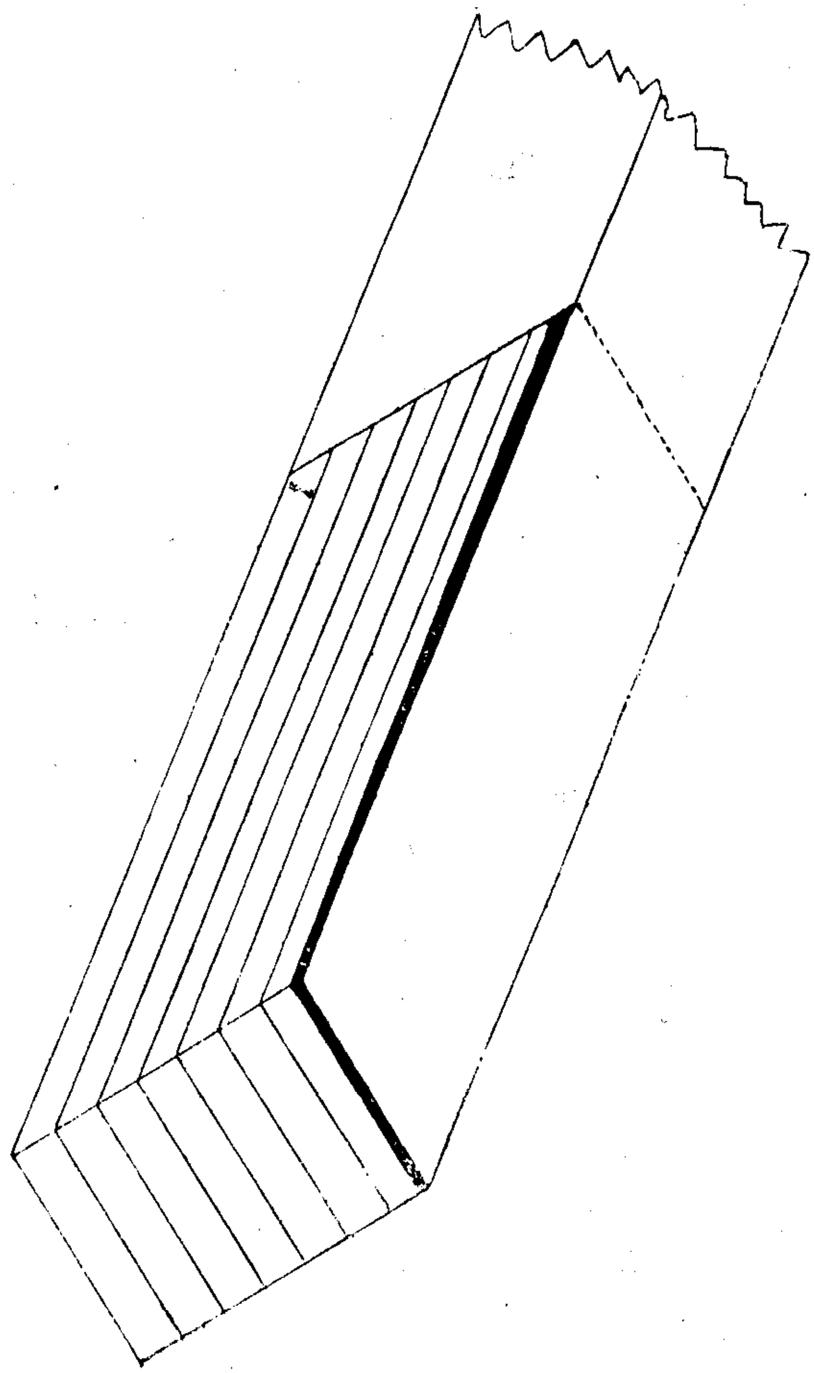
Profit on 2,240,000 „ = „ 17,640.

10. As to the ability of being able to dispose of 2¼ million shingles it is only necessary to say that even a small house of about 24′ × 24′ takes about 8,000 shingles and it would take only 280 such houses to absorb the lot.

Shingles at the rate quoted would compete not only with cast iron but would tend to oust even the use of *dhani* palm leaves and *theke* grass, as in the long run the shingles would be cheaper, far less troublesome and more immune from fire.

11. The question of teak shingles is a very different proposition as they can only be profitably cut from refuse timber. Nevertheless

under a totally different system of working the possibilities are even greater than with junglewood shingles.



A LUCKY THIRD SHOT.

BY D. A. ALLAN, P.F.S.

The Bedin was a well-known elephant in the Thayetmyo district, and many attempts had been made to bag him : the last was by Captain A., about two years before I had the good fortune to get him. I was on my way up to the East Yoma reserve, to do some girdling, when I was informed by the local forester that Bedin was having a glorious time in the paddy fields of the Aingwun village, about five miles away, and that he had been in the vicinity for about a fortnight.

I started out after him early next morning and picked up his tracks about two hours after leaving camp. A track of about two hours followed and then we heard the welcome sound of bamboos being broken and knew we were up with him.

I left all the men I had along with me except one at the place where we first heard of the elephant and went on with one man.

I came on him at the edge of some bamboo forest close to an old 'taungya' overgrown with high Kaing grass, in which he had been feeding during the early part of the morning. As the sun warmed up, he got into the bamboo jungle.

The first I saw of my intended victim was his hind quarters and the ends of his tusks and then I knew why he was called Bedin. The left tusk had a very exaggerated upward curve which made the tip of it stick out much higher than the right tusk (Be-din : left side raised).

Poor old Bedin, he was standing broadside on to me about 15 yards away, behind a large bamboo clump and every now and again I could see his trunk go up to break down a culm. The difficulty now was to get a shot before he winded me. I crept up another two or three paces and could get no closer, as there was a deep water-course between us and any attempt to get over this would have brought down an avalanche of stones and mud which would have given me away. The best I could do was to creep down the side of the hill along the edge of the water-course in the

direction in which he was facing, so as to get out of the line of the bamboo clump and then take a steady shot; I had partly accomplished my object and could just see a part of his head between the bamboos, when up went his trunk and I knew he had winded me, so had a shot at what I thought was the ear-hole.

The shot must have been deflected by a bamboo, for I made a clean miss and he turned and went off, like a steam engine, in the direction of the 'taungya' in which he had been feeding in the early part of the morning; but to do so he had to run uphill and diagonally across me. I gave him a second shot as he was crossing me which had no effect and a third just as he was about to top the hill. The last shot brought him rolling down hill almost on top of me, but he got up again and tried to make off; however, he was too far gone now to be able to get away and I eventually killed him about a hundred and fifty yards from where he was when I first saw him.

What a prize! the tusks when cut out were: Left side 6 ft. 6½ inches, right side 5 ft. 7 inches, girth of both 17 inches, weight 112 lbs.

In the hurry and excitement of starting in the morning, I forgot to take a tape with me so was unable to get his height, but from the measurements I made of the forefeet I made him out to be about 9 ft. 6 inches. Poor old elephant! He had had a rough time of it. I found two old wounds both healed up externally but on being cut open were full of matter. One was close to where the neck joins the body and the other at the back of one of the hind legs just above the foot, an apparent attempt to hamstring him. Needless to say, there was great jubilation among the villagers. They said once he got into a paddy field at night there was no getting him out of it. One sport said "he has been feeding on us for years and now we are going to feed on him."

EXPERIMENTAL SOWING AND PLANTING OF *CUPRESSUS GLABRA* IN GARHWAL (U. P.).

BY MATHURA PRASAD BHOLA, PROVINCIAL FOREST SERVICE.

A packet of seed of *Cupressus glabra*, a recently discovered Cypress, was received from the United States Department of Agriculture through the President, Forest Research Institute and College, Dehra Dun, in September 1916. The packet contained about 200 seeds. These were sown in the end of September in beds of the central nursery at Nagdeo near Pauri (Garhwal). The nursery is at an elevation of 5,700 ft. and is exposed fully to the effects of sun and rain, with north-eastern aspect, easy slope and shaly soil. The average rainfall at Nagdeo is 60 inches. The soil in the nursery beds was thoroughly worked and mixed with well-rotted humus before sowing the seed in lines 3 inches apart from each other. On account of scanty rainfall, the beds were watered by hand eight times in the month of October and germination took place early in November, only 16 per cent. of the seed germinating. There were no winter rains from November 1916 to the beginning of March 1917 and consequently hand watering of the seedlings was resorted to daily during this period. Thereafter there were almost continual rains and artificial watering was stopped.

The seedlings were inspected on 19th June 1917. There were 31 of them alive, all in healthy condition with an average height of 6 inches, the continual rains having evidently benefited them very much.

In the beginning of the following July, six of these plants were transferred into baskets and kept in the nursery for a month and were put out in August 1917 in an area near Nagdeo intended for reafforestation, enclosed by a walling and closed to grazing and fire. The situation of the area with regard to light, rain, aspect, soil, etc., is the same as described above for the central nursery. Pits spacious enough to accommodate the basketted plants were dug 5 ft. apart from each other and one plant was put in each, with surface soil, freed from stones, placed at the

bottom of the pit. Soil was firmly packed all round the basket in the pit, keeping the upper edge of the basket just below the surface of the ground with a little slope outward to drain off superfluous water. An inspection of the plants made on 15th February 1918 showed that five of them were flourishing and in very good condition and were on an average ten inches in height, while the sixth was sickly and there was very little hope of its surviving. No artificial watering and no tending of the plants was done, except hat rank growth round the pits was cleared at the time of planting. The monsoon rains of 1917 were plentiful and the winter rains of 1917-18 were almost normal.

The remaining 25 seedlings were pricked out in the nursery beds in the month of July 1917 and placed 6 inches apart from each other. On the 15th February 1918, 13 plants were found to be in quite a healthy condition, their average height being 13 inches. Of the rest, eight were sickly with an average height of 6 inches with no promise of future and four were dead. The plants were watered by hand now and then. They will be put out in the next monsoon rains.

The experiment of sowing and planting this exotic species being of considerable botanical interest, further development of the plants will be observed and published in the *Indian Forester.*

IMPORTS OF JARRAH TIMBER INTO BRITISH INDIA DURING THE YEARS 1912-13 TO 1916-17.

We have received a letter from Millars' Timber and Trading Company, Limited, Bombay, pointing out what appears to be a mistake in the figure we quoted for the Imports of Jarrah Wood into India on page 21 of the *Indian Forester* for January 1918.

We are taking steps to have our figures verified and in the meantime we publish below the firm's letter and statement of imports :—

DEAR SIR,—In the *Indian Forester* of January, page 21, it is shown therein that Jarrah wood aggregating *24,477 tons was

* (The correct total is 24,615 tons and not 24,477 tons.)

imported into India during the period from 1912-13 to 1916-17. As this statement is not in accordance with facts, we beg to enclose herewith figures taken from the books of the Company, which tell a very different tale, and we feel sure you will take the earliest opportunity to place before your readers a correct statement which may be verified at any time.

A reference to our accompanying statement will show that Jarrah wood aggregating 111,786 tons was imported during the period from 1912-13 to 1916-17.

Since the outbreak of war imports have gone down, and now as no steamers are available imports for the time being are stopped.

Yours faithfully,

MILLARS' TIMBER AND TRADING CO., LTD.

Dated 14*th February* 1918.

Millars' Timber and Trading Co., Ld. Jarrah Timber imported into India from 1912 to 1917.

	1912-13.		1913-14.		1914-15.		1915-16.		1916-17.	
	Quantity.		Quantity.		Quantity.		Quantity.		Quantity.	
	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.
April—June ...	4,546	26 9 3	11,319	48 6 6	14,710	24 4 11	2,408	3 5 7		
July—September ...	8,634	4 6 2	4,504	13 5 9	6,945	28 1 4	3,577	24 11 10		*Nil.*
October—December ...	15,981	19 1 11	18,451	19 9 5	4,263	40 6 2	...	...	No steamers available.	
January—March ...	3,540	12 2 4	9,112	16 11 2	3,791	30 2 2	...	...		
Total ...	32,701	12 7 8	43,387	48 8 10	29,711	23 2 7	5,985	28 5 5		

SUMMARY.

	Tons	C ft. in. pts.
1912-13 ...	32,701	12 7 8
1913-14 ...	43,387	48 8 10
1914-15 ...	29,711	23 2 7
1915-16 ...	5,985	28 5 5
1916-17 ...	...	...
Total ...	111,786	13 0 6

NOTE:—1 Ton = 50 cubic feet.

EXTRACTS.

NATURAL REGENERATION OF CONIFERS IN THE PACIFIC COAST FORESTS OF THE UNITED STATES.

In a study of the natural regeneration of the Douglas fir and other conifers in the Pacific coast forests of the United States, published in the *Journal of Agricultural Research*, Vol. XI, pp. 1—26 (October 1917), J. V. Hofmann shows that when a large area is either burnt or cut away the complete restocking which usually takes place does not result from the seeds that are scattered by surviving trees on the area or in its vicinity. The distance from the parent tree to which seed is carried by the wind is very small, 150 to 300 ft. Consequently, if only wind-dispersed seed germinated, the regeneration of a large area would not be completed until after the growth of several generations of trees. The reproduction is never a gradual creeping out from surrounding bodies of green trees, but is a sudden taking possession of the whole area by a dense growth of seedlings. The regeneration is really effected by the seed which is stored in the ground amidst the litter and humus, which are not destroyed in the swift passage of the ordinary forest fire. The litter is found on examination to

contain a large number of germinable seed. The ordinary form of succession is the replacement of the forest almost immediately by the same species as composed the original stand, and usually in the same proportions. This paper is well illustrated with diagrams and photographs. One plate is a view of the reproduction on the Yacolt "Burn" of 1902 in the Columbia National Forest. The extent devastated by fire is 604,000 acres. No green trees are visible, yet there are seedlings growing among the snags over the whole area.—[*Nature.*]

[The above is equally true under certain Indian conditions. A big fire occurred in 1903 on the Rimbick Spur (Darjeeling) between 7,500 and 10,000 ft. altitude. The forest consisted of Oaks, Chestnuts, Magnolias, Hemlock spruce, etc., and in the upper portion Silver Fir.

There was a dense undergrowth of Maling bamboos (*Arundinaria racemosa*). The forest happened to be in an unusually dry state at the time of the fire, so much so that in the passage of the fire the green bamboos dried and burnt giving rise to a fire of extraordinary intensity resulting in the total destruction of the forest.

This forest had never been burnt before in the memory of man, and trees of 12 to 18 ft. in girth were not uncommon; as a result of the fire, however, not a tree survived.

The ground resembled a charcoal kiln and it seemed almost impossible that seeds even buried in the soil, could have survived. However, to the great surprise of the writer, two months later, at the burst of the monsoon, the seedlings appeared everywhere especially *Magnolia Campbellii.*

It would be interesting to learn the condition of the crop at present.—HON. ED.]

WOOD DISTILLATION.

The distillation of wood from our Indian forests is an industry that must one day be taken up seriously, it being clear from a note on the subject in the *Bulletin of the Imperial Institute* that it will bring in a good return. The demand for oils and tar in this country is steadily increasing, and one day the demand for alcohol will also become insistent. If wood distillation in India itsef can give us what creosote, tar and alcohol we need for use in our oil engines, for the preservation of our timber and for use on our roads, the sooner we take to manufacturing them on the spot the better. It is unlikely that the price of any of these when imported will ever fall much, and as they now stand India is unable to

compete with other countries in such industries as depend largely on these three products of wood distillation. Besides these there are other by-products such as acetate of lime, acetic acid, acetone and charcoal, the first three always in great demand and in greater demand than ever at the present time for munition purposes. The hard woods and the soft woods give differing results after distillation. The first give low yields of black, viscous, ill-smelling tar but high yields of acetic acid and wood spirit (methyl alcohol). Two typical woods may be taken for example, the one hard the other soft, and their distillation products compared.

	Oak Wood. Per cent.	Pine Wood. Per cent.
Acetic acid	... 4·4	2·2
Equivalent to acetate of lime	... 5·8	2·9
Methyl alcohol ...	... 1·1	0·6
Tar, separated ...	... 6·4	12·9
Charcoal	... 25	29

The crude acid when redistilled and neutralized with lime produces grey acetate of lime, the value of which is at present £36 per ton, whereas before the war it was only £8 per ton. There is a large demand for it for the extraction of acetone. Some of it is manufactured in Ceylon and the Imperial Institute, on behalf of the Home Government, is enquiring if any of it is available for export. Acetone is required in large quantities for the manufacture of propellant explosives. Acetic acid is produced in large quantities in Ceylon and used in the preparation of rubber. Cocoanut shells when distilled give a good yield of acetic acid and produce also creosote required for the preparation of smoked rubber. There is also a timber known as Vera wood growing in the dry zone of Ceylon from which is distilled crude acetic acid liquor, charcoal and tar, in fair quantities. By redistilling the crude liquor, after the addition of fresh charcoal, a pale yellow, clear solution of acetic acid is produced. Methyl alcohol is the chief constituent of the commercial product known as wood alcohol or wood spirit, which includes some acetone, esters and other products. The value of this product in July 1914 was

2s. 7d. per gallon but at the close of 1916 had risen to 5s. 6d. It has already been stated that the distillation products of hard woods and of soft woods differ somewhat. In considering tar it must be noted that hard wood tars cannot be used for treating ropes and twine. Soft wood tars, on the contrary, such as those obtained from pines and coming on the market under the name of Baltic and Stockholm tars, are the ones suited for this purpose. There is, in fact, not much scope for the use of hard wood tars except in the way of fuel. Noting that black wattle wood and olive wood experimented on at the Imperial Institute were obtained from the East Africa Protectorate, the Institute give us the following table of distillation products:—

	Acetate of Lime.	Wood Spirit.	Tar.	Charcoal.
Oak Wood—				
Yield per ton	112 lbs. ...	3½ gals. ...	100 lbs. ...	580 lbs.
Value of yield, June 1914 ...	...	8s. 4½d. ...	1s. 9d. – 2s. 3d.	14s. 10d.
" " Dec. 1916 ...	£1 16s. ...	17s. 10½d.	...	...
Black Wattle Wood—				
Yield per ton	139 lbs. ...	3·7 gals. ...	134 lbs.	605 lbs.
Value of yield, June 1914 ...	9s. 11d. ...	9s. 6¾d. ...	2s. 4⅜d. – 3s.	15s. 6½d.
" " Dec. 1916 ...	£2 4s 10d.	£1 0s. 4d.	...	...
Olive Wood—				
Yield per ton	90 lbs. ...	5·0 gals. ...	166 lbs.	650 lbs.
Value of yield, June 1914 ...	6s. 5d. ...	12s. 9d. ...	2s. 11½d. – 3s. 8½d.	16s. 8d.
" " Dec. 1916 ...	£1 8s. 1d.	£1 7s. 6d.	...	...

It will be seen that, taking the prices obtainable in June 1914, which may be regarded as normal, both wattle wood and olive wood show a slight advantage over oak wood, and should, therefore, be at least as profitable to distil.

Practically the whole of the imports of the products of wood distillation are retained in the United Kingdom; further, the only country of the Empire which supplies the United Kingdom with

any of these products is Canada. This is extremely unsatisfactory both for the United Kingdom and for India. We in India cannot get them even from Home and must depend on foreign countries for what we need when we have in more than abundance the materials in our forests that could supply both Indian and Home needs. If and when the Forest Department wakes up to its possibilities let this matter of wood distilliation, therefore, not be forgotten.—[*Indian Engineering.*]

[The Forest Department is fully alive to the possibilities of wood distillation.

Just at present, with the price for acetate of lime unduly inflated by war conditions, wood distillation would probably pay almost anywhere, but unfortunately the necessary plant is not now procurable. When normal conditions reassert themselves the conditions necessary for success are that each and all of the products of distillation should find a ready sale in the country of production. It is in this respect that Indian forests are at present at a disadvantage as compared with those in America or in Europe, where the proximity of big industrial and chemical concerns ensures a demand for all the products of distillation—HON ED.]

NOTES ON DRY ROT.

India is a country in which timber is very susceptible to dry rot while few realize the extremely "epidemic" character of the disease. A paper by Mr. E. J. Goodacre, Assistant Borough Surveyor, Shrewsbury, brings together much useful information regarding the character of the disease and how it should be prevented, but even he admits that much remains to be studied on the subject. That it is virulent, spreading, and hard to eradicate is certain, its very insidiousness making it difficult to detect; it is also certain that the destruction and loss caused by it is enormous because of its insidiousness. So far three forms of the disease have been recognized—(1) *Merulius lacrymans*, (2) *Coniophora cerebella*, (3) *Polyporus vaporarius*. The first has been so named because of its dark colouration accompanied by the collection of fluid globules; it prevails in moderate climates and where subsoils of a clayey nature exist. It does not need moisture for its support so that once established it can develop on and destroy the very driest timbers. In appearance it takes the form

of dark brown rusty patches with white margins; these are large and undulating and contain the spores, when they face upwards the spores become infertile, when downwards the spores are fertile and of great vitality, living for many months together when kept dry. From the patches above noted there spread out what are known as hyphæ which also produce spores and spread the disease; they weave themselves into strands or cushions known as the mycelium, requiring no moisture for their sustenance, so that they can extend themselves over brickwork and even glass to attack other timber a long way off. Of the three this type of dry rot is the most malignant. *Coniophora cerebella* resembles *merulius lacrymans* in appearance but requires moisture for its subsistence, for which reason it can be more readily dealt with; its mycelium consists of slender black threads in great profusion. *Polyporus vaporarius*, or red rot, has white squares, its hyphæ become very tough when old instead of brittle; in deal it is seen in red decayed patches, hence its name.

All spores being of miscroscopic size can float away long distances in the air and cause infection far and wide provided they meet with congenial germinating spots, which are chiefly moisture and moderate temperature, *coniophora* requires a good deal of moisture, and hence germinates in very damp situations. The other two, *merulius* in particular, when once established, can grow on the driest wood, depending on their own power for the production of moisture. *Merulius* also, though it thrives in a moderate temperature, is killed by one of 40° C. So that infected wood, if heated above 40° C., can be sterilized, and that steaming has a curative effect. Dry rot generally progresses much faster in summer than in winter in an ordinary building which is heated and thus has its air made relatively dry during the winter months. When timber is effected it should be tested by boring holes at intervals; if there is dry rot the borings will show a brown powder. The dull sound made by a hammer is also a means of detection and often the distinctive smell of the disease. Infection commonly takes place in the timber yard itself and therefore it is recommended that all such yards be paved with tar-macadam. Stacked timber

should be seasoned, be kept dry and well ventilated and even, if possible, desiccated or stoved to a temperature of 50° to 60° C. During construction timber should be protected against wet and in construction secured by good ventilation; floor joists, especially ground floor joists, should be creosoted; all rejectable earth should be removed from under floors; and the building site should be covered with at least 4 inches of cement concrete, asphalted on the upper surface or with tar-macadam. The method is of course expensive but necessary where conditions point to the practical certainty of destruction by dry rot. Under-ventilation should be provided by fixing fresh air inlets on all sides with an extraction flue taken up the chimney breast alongside the smoke flues. The ends of all joists should be fixed in such a manner that there is a passage of air all round the end of the joist as far as possible. Shavings left under the floor boards often originated dry rot; in cases where boards or wood blocks are fixed directly on the concrete, they should be bedded on some bitumastic compound. Skirtings and other wall mouldings should be fixed after the walls are dry and should preferably have a backing of cement rendering, damp-proof courses are always necessary, they may be of lead, asphalt, bitumastic compounds on fabric, or slates in cement. Hollow walls too are a good precaution against dry rot.

When dry rot has been established the infected wood should be oiled to keep down the spores, then be removed and burned, the tools used for the purpose should be sterilized, the brickwork and stonework should be sterilized by a blast flame, and the woodwork should be dried and treated with a wash of dilute formalin or carbolic acid. Hot limewash is very useful for a mild attack, and, in fact, most antiseptics are more or less effective. It must, however, be always remembered that the only real safety lies in prevention and that crores may or may not reach all parts of an infected structure.—[*Indian Engineering.*]

[So far as we are aware no dry rot fungus has yet been definitely identified in India.—HON. ED.]

MATCH-MAKING IN INDIA.

The annual report of the Director of Industries for the United Provinces states that despite valiant attempts to keep going on, the Bareilly Match Factory have been compelled to close down their works at the end of May 1917. The difficulties with regard to wood were successfully overcome with the aid of Government, but it has been found impossible to compete with imports owing to the prohibitive prices which have had to be paid for chemicals, while it has also been found impossible to get supplies of the special paper which is used for binding and covering the boxes. The requisite chemicals are not yet made in India, nor has it been found practicable so far to secure a satisfactory paper in India. Whether it will be found possible to recommence operations after the war cannot at present be determined, but it appears to be clear that match-making industry will never be established upon a sound basis in India until a larger proportion of the requisites of manufacture are produced locally, or some special treatment is accorded to this industry which will serve to compensate for the heavy costs of chemicals when imported from abroad. Under ordinary conditions sea freight from the countries supplying India with matches are less than the railway freight for an average inland lead in India, so that the Indian manufacturer derives little advantage from his location. Nor is he much better off than his foreign competitor in the matter of Customs duty when he pays the full tariff duty on all the ingredients and paper which he imports because local supplies are not available. The total imports of matches for the year ended March 31st, 1917, were valued at Rs. 1,15,69,771, the average price being a fraction over one rupee per gross.—[*The Oil and Colour Trades Journal.*]

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BURMA JUNGLE WOODS AND THE EUROPE MARKET.

(Contributed.)

Some readers of the Indian Forest Service may remember a Scotch story ending with the words "Is that a fact? No, it's a prophecy." Such ought to be the text for any discourse on the subject of this article, but prophecy or not, it is quite worth while glancing, if only cursorily, at the main difficulties which are bound to crop up whenever we attempt to gain a firm position in the Europe market for our Burma jungle woods.

Mr. Macmillan in his article which appeared in the *Indian Forester* of September 1916 pointed out very clearly the chief difficulty we have to overcome, and it may be briefly summed up in the phrase "Ship-loads for barrow-loads of each sort separately." A second problem to which Mr. Macmillan refers in his article, although not laying the same stress on it that he did when the writer had the pleasure of touring and discussing the subject of this article with him, is that of uniform quality, which means *sorting*

and *seasoning*. The above two problems do not concern the territorial Divisional Forest Officer so much as the supreme authorities who direct the fortunes of the forests of the province as a whole, but there remains a third upon which the solution of the other two will ultimately depend, and this third problem will have to be solved separately in practically each division in the province. This problem to be solved is the adjustment of silvicultural systems to satisfy the requirements of scientific silviculture and the conditions best suited to meet the call for ship-loads of uniform quality, in other words wholesale extraction.

The war has given Burma an unique opportunity in the way of advertising her wares. It has also compelled her to start the solution of the problem of "Ship-loads for barrow-loads"; but what is perhaps still more important it has given her a chance of testing the industrial value of her timbers on a scale large enough to give useful and trustworthy results. It will be an unpardonable scientific and commercial sin if the province does not do the utmost possible to garner all the information which is to be gained from this test. Hitherto, except in the case of a very limited number of species, the only information obtained has come from factory or laboratory tests on a small scale, carried out with rather restricted objects which have limited the conditions of the test. The timber which Burma has supplied during the last year for military use is being tested to destruction under a variety of conditions and for a multiplicity of purposes which would never have been dreamt of in times of peace. Information as to the results of these tests will have to be collected from those who have seen this timber in actual use. This information will be of very great use but unfortunately will not be the best that one might have hoped for. The ideal would have been to have this information collected by forest officers who are acquainted with the timber in the tree, in transit and in the saw-mill, and who would therefore be able to collate their knowledge of the timber in all its stages when examining and criticising the results of its being tested in actual use. The shortage of staff due to the war obviously banishes this ideal. We must be content with the next best but the important

thing is not to lose this second best for want of foresight and organization.

To return to the main problems. At the end of the war we may or may not be in a position to give useful information to the trade as to the industrial value of most or many of our jungle wood species. But, whether we can or not the fact remains that even before the war, America, the greatest consumer of hardwoods and at the same time the greatest supplier of hardwoods (jungle woods) to the markets of Europe, was beginning to seek new sources of supply in the Philippines, Borneo and Siam. Some of the timbers from these countries, we may safely say, are special timbers of which we cannot find "opposite numbers" in Burma. On the other hand, Mr. Macmillan had no doubt whatever that Burma has timbers which could supplement or replace those which America, with steadily diminishing stocks, is supplying to the markets of Europe and for which she is seeking for substitutes to supply her own needs. Why, then, should Burma or any other suitable part of India not try to catch some of the golden rain? Clearly the first condition is to be able to supply a recognized timber in sufficient quantity. We have done so already in the case of teak, but teak is in a class by itself and cannot be used as a criterion Certain other timbers have a precarious footing on the Europe markets such as In and Kanyin (under the name of Yang teak), Pyinma (*Lagerstrœmia Flos Reginæ*) and Padauk (*Pterocarpus* spp.), but they cannot be compared with American oaks, ash or walnut, for instance, as standard trade timbers. One reason is clear. In peace time one could buy American oak or walnut every day of the week, both "spot" and futures, with the utmost confidence while Yang teak or Padauk was little on "spot" and vague as to futures, if forward buying in these timbers was ever done. Burma was supplying only barrow-loads at uncertain intervals instead of regular ship-loads. If Burma is to gain a footing of any sort in the Europe market she must be in a position to supply an industrially useful quantity of any of her timbers, which are now or will be recognized as industrially useful in quantity, on demand or at short notice. How can this quantity be obtained? Leaving aside quality

considerations, it would be almost impossible to find, at the present moment, any single forest unit (division) which of itself could supply a year's demand of any timber which came to be recognized as industrially useful in the Europe market, even if we assume the communications and other means of extraction to be far in advance of what they are at present. Teak is an outstanding example of this. To put it broadly, extraction of teak has to go on in every division in Burma to supply the normal demand and teak is the only timber which Burma has supplied by the ship-load or did until recently. This means that to place any one timber or any of several on the market at home we must contemplate exploiting the province as a whole and not piecemeal. Straight away comes the question, "By what agency can we exploit the province as a whole?" The profits on teak exploitation are so great that foreign capital has found it worth while to engage in it, but even so, compared with the area of the forests of the province, the agencies exploiting teak are strangely small in number. The net profits to be expected from the exploitation of jungle woods are very much smaller than those realized from teak, which means that for jungle wood exploitation to be profitable from the point of view of foreign capital, the capital must be even more concentrated than in the case of teak exploitation. In other words, the exploitation of a small number of recognized jungle woods must be undertaken by a monopolist in place of even a small group of exploiters. Apart from objections on principle to monopolies, it is now recognized that there are serious objections to partial monopolies from a forest point of view. It has been found that in the case of leases of large forest areas or forest leases for long terms, which constitute in fact modified monopolies, the legitimate commercial interests of the lessees are, to a great extent, antagonistic to the silvicultural interests of our forests. Although this antagonism may not be of overwhelming importance where only a small fraction of the forest crop is concerned, it would make proper silviculture impossible if the major part of the forest crop were involved. The alternative to a monopoly is to have a number of small exploiting agencies supplying one

or a few collecting agencies, middlemen or brokers who will look after the provision of a proper quantity of timber to the market in Europe. These collecting agencies do not exist at present; they must be evolved. In the meanwhile, the war has shown us what can be done in their absence. We have created an agency by which the supplies of many small exploiters have been collected so that useful quantities of various sizes, qualities and species have been made available where they were wanted. Big and large it amounts to Government having arranged to pool the output of the small agencies, ensuring to these agencies a remunerative price and the result has been the provision, for military purposes, of quantities of timber of proper quality, to an extent that no one ever imagined possible. It is true that we have supplied species which a keenly competitive industrial market would not have accepted but, on the other hand, we have had to adapt ourselves to demands and conditions most staggeringly unbusiness-like which have been imposed on us by the military authorities. Anyhow we have succeeded in producing ship-loads instead of barrow-loads, and so far the results are satisfactory if judged by the steady demand for this timber. Here is the foundation of an organization to put proper supplies on to the market. The military timber supply organization is now in touch with almost every saw-mill in the country. By a relatively slight extension of its organization it should, in peace time, be in a position to know the total stock available at any one time, and in response to any enquiry from the market be able to put, before the millers, a price for their stock which would bring the millers to place their stocks at its disposal so that the market would get a sufficient supply. On the other hand, the millers would be in a position to sell the whole of their stock so keeping their mills going for a profitable period instead of trusting to hand-to-mouth local orders with the concomitant idle capital and overhead charges, which make jungle wood milling such a precarious investment in Burma. The military timber supply organization in its garb of peace might also play an important rôle by sending to Europe suitable consignments of some of our lesser known timbers with a view to creating a demand for them.

Facilities for storing timber while deliveries from up-country accumulate would have to be provided and possibly it might be found worth while for Government to carry stocks of certain timbers. Better loading facilities than exist at present would have to be forthcoming in Rangoon as it is important that every item of avoidable cost should be cut out.

Later when the trade gets well established, it will be possible to reduce the price of the timber by improvements in logging and milling; but, at the start, millers are not likely to spend the money necessary for this. The importance of cutting the cost of the timber by every possible means ought never to be lost sight of. At present actual extraction and milling costs, as well as rail and steamer freight are, we may say, fixed quantities which the Forest Department can do little directly to alter. The extractor's and miller's profits cannot be influenced much so that initially almost the only way in which Government can help is by eliminating avoidable causes of cost, such as unnecessary handling, length of storage, demurrage of trucks and so on, items which, though apparently trifling, may make all the difference between success and failure in seeking for a footing in a competitive market. From the immediate stand-point of a timber trader, Burma is handicapped by possessing a Forest Department and Forest Policy as compared with countries where unrestricted logging is allowed. It is, therefore, the duty of Government to see that the handicap of a prudent Forest Department (can we say prudent policy?) is counterbalanced by intelligent help in other directions. The solution that the writer would suggest to the first problem is to have an organization founded on that which has worked so well so far for military supplies, to act as collecting agent, middleman and exporter for the widely scattered mills of the province until the trade becomes set firm on its feet, after which the organization would become more and more assimilated with the advisory branch of Forest Economic Research in Burma and its place as middleman taken over by private concerns. It is hardly necessary to add that such an organization will be worse than useless to the province unless from the very outset it is built up and run on genuine and not quasi-commercial lines, free from

the burden of making up endless returns and from the hobbles of lapsing grants and microscopic spending powers.

Quality.—Next to being able to guarantee quantity, Burma must be able to standardize, if not guarantee, the quality of its timber. Up to now no proper attempt has been made to tackle the question of the quality of Burma timbers Practically speaking, if a timber cannot stand the ordeal of being either converted and utilized green or else of being left about on the ground alternately exposed to drought and damp, fungi and borers before conversion, it has been put down in Burma as worthless from a commercial point of view. Few, if any, hardwoods commonly used in Europe would stand the above ordeal. The result of the ordeal in Burma, even with timbers which survive it, is a hopeless unevenness of quality. The secret of success lies in finding out for each species the simplest method by which the objectionable features of seasoning can be eliminated. These difficulties have been got over in America and recent Indian experience points out how a start can be made. The tendency of the research which has so far been made in India and Burma has been too much of a "hit or miss" nature Instead of trying to find out what main factors influence the seasoning of any particular species and basing the seasoning method on that, we have gone the other way about and adopting a method have grouped the timbers according to whether they suited the method or not. It is almost certain that no one method will be found suitable for more than a very few species at most. Probably each species will need special but very likely only small modifications. Modern seasoning practice seems to aim at getting the timber as quickly under control as possible and to hasten the process of seasoning as much as possible. The last consideration is one which demands special consideration in a country where high rates of interest necessitate a rapid turn-over and where the climate favours rapid deterioration both in strength and appearance of timber. Before trying to develop a large trade in hardwoods, the department ought to examine all the modern systems of seasoning timber not merely theoretically but as carried

out in actual practice, and then experiment on the system which seems best suited to the other conditions of the Burma timber trade. It is not in the least likely that any system can be adopted *en bloc* from western practice As in silviculture, a modification of the best system must be built up. For this purpose two types of expert will be needed. The one, with the knowledge of the working conditions of the Burma trade, who will be able to select the system and the other, the seasoning technologist who can suggest the needful modifications as experiment proceeds. Either separately will achieve little. Quality, apart from seasoning, rests with the millers in the long run but, at first, will need to be looked after carefully by the middleman whoever he may be.

The silvicultural problem.—The prosperity of the American hardwood trade, notwithstanding the wealth of brains and money that it has at its disposal, lies in the fact that for years it was never hampered by the existence of a State Forest Department. Wholesale or destructive logging has been the order of the day, hence from a commercial point of view it enjoys advantages which the trade in Burma can never hope for. To compete in any way with the American or any other hardwood trade similarly conditioned, the Forest Department in Burma has to try and introduce wholesale logging and yet eliminate the destructive aspect. Luckily, the present is a good moment to look into this question. It is now realized that the Selection system, with brute force and ignorance (apologies are due to the large teak firms) as the foundation of its extraction work, is out of date and must drop into the background. Concentrated silviculture is the order of the future and this implies concentrated extraction, if the former is to be a financial success. The hardwood trade, however, needs something more than extraction concentrated as to area, it needs the extraction to be concentrated also as to time. In all but a few exceptionally favoured areas, Burma hardwoods will have to bear a heavy overhead charge in the shape of capital expenses for logging and transport. The charges are directly proportional to the time needed to get the most economical volume outturn which must be dealt with by

whatever plant is put down, as for instance railways, skidders, saw-mills, seasoning plant, etc. For example, long protracted regeneration periods such as we know in Europe, where only a relatively small volume per unit of area is dealt with at a time, are out of the question. How to get the old crop off quickly and the new one on quickly is the question in Burma. Fortunately, for Burma, it seems as if the process is not going to be so difficult as would appear at first sight. The method of regeneration by what has been ironically called "destructive fellings" seems to solve the problem for at least one widely distributed type of forest. This method gives ample regeneration of the sacred teak and appears not to be positively harmful to other useful species. Moreover, from the fact that it requires a fierce burning of the ground for its success it admits of a certain amount of selective extraction as a preliminary process and does not necessarily require the removal by the logger of a number of species which, for the present, may be classed as valueless for timber, though useful in helping the burning of the ground.

To examine all the various systems and methods of concentrated regeneration which have been discussed or experimented with recently is outside the scope of this article. What is important is for the department to remember that, in the future, teak will not, and should not, be the sole object of a forest officer's consideration, and that when any silvicultural innovations are considered due weight should be given to the question "Is concentrated economical extraction favoured by this innovation?" It must not be forgotten too that economical extraction of jungle woods means the same for teak.

And lastly, this article has not dealt with the subject of communications. It has been assumed that proper communications are recognized by the supreme powers as a preliminary to all development of the jungle wood trade. It has hitherto been the policy to wait for the demand to arise before starting to open up a forest by proper communications. This does all very well when local hand-to-mouth trade only is concerned. If we wait for the Europe trade to come to us before we make

our main forest roads and railways, we may as well fix now the date of "Our Day" of our export trade in jungle woods at Latter Lammas in the year after never at all. This is no prophecy, it's a fact.

HTAO HAI.

PRIZE-DAY AT THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

The annual prize distribution of both the Provincial Service and Ranger classes was held on the premises of the Forest Research Institute on the 26th March 1918, in the presence of Mr. G. S. Hart, C.I.E., the Inspector-General of Forests.

Mr. Osmaston, the President of the F. R. Institute, opened the proceedings by reading the following report :—

MR. HART, GENTLEMEN,

"This is the second occasion on which the Provincial Service and Ranger classes have completed their courses of training simultaneously.

"In my report I must deal with the two classes separately and I commence with—

"*The Provincial Service class.*—This class, limited to 20 students, actually commenced with 19, but was subsequently reduced to 18 by the removal of one student for misconduct.

"It is the largest class up to date. The course of instruction which commenced on the 1st July 1916 has extended over 21 months only. In future, the period of training will cover the full two years. The portion of the training which has been missed is what used to be styled the second hill tour.

"Instruction in Working Plans which used to be given on this tour was, in the case of the present class, given during their one and only hill tour at the end of their first year.

"In their second cold weather it was proposed to take them to the Central Provinces. This tour was, however, unfortunately prevented owing to the local Forest Staff being occupied with grass-cutting in connection with war work.

" A most instructive tour in South India was undertaken in January and February of their second year.

" The class as a whole is well above the average.

" The student who tops the list and who has earned the Gold Medal thoroughly deserves it, having obtained the high total of 92 per cent. of the total marks obtainable. He stood first in every subject but one, and takes every prize and medal for which he is eligible, with the exception of that for the best athlete.

" Two others have obtained over 80 per cent. of full marks thereby obtaining Honours.

" The rest of the class maintain a consistently good average.

" The standard of Honours has this year been raised from 75 per cent. to 80 per cent. of the total marks available.

" Last year, none attained 80 per cent. of full marks, and the top man would have occupied 7th place on this year's list. The high average of this year's class is also indicated by the fact that the average number of marks obtained by the whole class is 75 per cent. as against 68 last year.

" There is a rather regrettable tendency, natural perhaps for students who excel in any particular subject to drop that subject in which they feel confident to qualify and to devote themselves to other subjects in which they are weaker. This was specially marked in the case of the two students with a Bachelor of Science degree who are lower in their Science examinations than they should be.

" The health of the students was good."

" *The Ranger Class.*—This class consisted originally of 38 members. Of these two were dismissed during the first year for respectively rendering and accepting unfair assistance during examinations, two resigned and one was forced by ill-health to drop a year. In this way 33 only completed the course.

" The class, as a whole, is above the standard of the last few years, but it does not contain many men of outstanding ability.

" In addition to the usual two hill tours, and one in the Siwalik Division, this class was enabled to pay a very interesting

and instructive visit to the sal forests of the Gorakhpur, Gonda, Bahraich and Kheri Divisions.

"The class has had to put up with unusually great inconveniences and hardships in camp: in the first hill tour on the break-down of transport from Bhowali in the rain; in the persistent bad weather of the 2nd hill tour culminating in being snowed up for two days in Mundali, and on several occasions in difficulties connected with the breaking down of cart transport on tour in the Siwaliks. The Instructor reports that through all these trials the class worked with praiseworthy cheerfulness and energy.

"Of the students who make up the class the Punjab and United Provinces men take the highest average place having secured 6 out of the 7 Honours. In fact, all three of the Punjab men have attained this distinction. The United Provinces men are reported to be all good practical men in the forest. The Central Provinces and Assam candidates rank lowest.

"I would strongly emphasize the importance in certain Provinces of exercising a very careful selection of candidates before they are sent to the College—more especially with a view to ascertaining their suitability for a forest career.

"The health of the students has been good."

"*Games and Sports.*—In athletics both classes compete together.

"The outgoing classes, as a whole, are scarcely up to the average of past years, though they include a few individual players as good as we ever get.

"I am glad to be able to say, however, that there has been a distinct improvement in attendance at, as well as in keenness in games, but even so there is much room for further improvement. We want to get rid of the 'slacker' and the 'passive resister' who not only take no interest themselves in sports and games, which is bad enough, but encourage others to emulate their bad example.

"In the sports Lindsay Smith won the Championship Cup from Hilbert by two points and the same student also wins the valuable cup presented by the Inspector-General of Forests to

the best all-round athlete. Hilbert runs him very close and is a good second."

The certificates were then distributed by the President, and the prizes by the Inspector-General of Forests.

PROVINCIAL SERVICE CLASS.

HONOURS CERTIFICATES.

Order of Merit.	
1.	T. V. Venkateswara Ayar (Madras).
2.	Bashir Ahmad (Kashmir).
3.	H. V. Rangaswamiengar (Mysore).

PASS CERTIFICATES.

4.	Vishambar Sahaya Goel (U. P.).
5.	B. S. Keshava Vittal (Madras).
6.	W. F. Coombs (U. P.).
7.	G. V. Trivedi (C. P.).
8.	Rama Subramanya Aiyar (Travancore).
9.	D. Lindsay-Smith (Burma).
10.	Madan Lal Khanna (Bombay).
11.	H. Hilbert (Burma).
12.	Debendra Nath Dutta (Bengal).
13.	C. L. Edwards (Burma).
14.	Maung Han (Burma).
15.	Maung Nee (Burma).
16.	F. C. Phaure (Burma).
17.	Maung Thein Swin (Burma).
18.	C. I. English (C. P.).

MEDALS AND OTHER PRIZES.

Gold Medal to the best student of the year with Honours Certificate.	T. V. Venkateswara Ayar. (Madras).	
Silver Medal to the best student in Forestry	Do.	do.
Do. do. in Botany	Do.	do.
Do. do. in Surveying	Do.	do.
Do. do. in Engineering ...	Do.	do.
The Hon'ble Member's Prize (for the most promising student)	Do.	do.
Hill Memorial Prize (for the best student in Silviculture) ...	Do.	do.
The "Indian Forester" Prize (best student who has got no other prize)	Bashir Ahmad (Kashmir).	
Inspector-General of Forests' Cup (for best athlete) ...	D Lindsay-Smith (Burma).	

RANGER CLASS.

HONOURS CERTIFICATES.

Order of Merit.		Order of Merit	
1.	Bhagat Singh (Punjab).	5.	D. R. Bahrucha (Bombay).
2	Suraj Mani Naithani (U. P.).	6.	Jagdish Chandra (Punjab).
3.	Bahadur Singh (U. P.).	7.	Durga Das (Punjab).
4	Saiyid Raunaq Ali (U. P.).		

HIGHER STANDARD CERTIFICATES.

8.	Ram Dat (U. P.).	19.	Atma Singh (Andamans).
9.	Manoranjan Roy Chaudhury (Bengal).	20.	Liladhar Shrivastava (Berar).
10.	Ashutosh Sanyal (Bihar & Orissa).	21.	N. C. M. Saldanha (Bombay).
11.	P. K. Mirchandani (Sind).	22.	Amar Singh (Berar).
12.	Balwant Singh (Berar).	23.	Munna Lal Patel (C. P.).
13.	Lal Singh (U. P.)	24.	Padmadhar Das (Assam).
14.	D. S. Kaikini (Bombay).	25.	Sultan Ahmad (U. P.)
15.	Gandharb Singh (Kashmir).	26.	Jagat Singh (U. P.).
16.	Kunja Behari Mukerjee (Bengal).	27.	Desai Vindoo Prasad (C. P.).
17.	G. F. D'Souza (Bombay).	28.	V. M. Deshpande (Bombay).
18.	Gulam Mahomad Kureshi (Sind).	29.	R. G. Sahsrabudhe (Bombay).
		30.	A. N. Chaudhury (Bengal).

LOWER STANDARD CERTIFICATES.

31. Sayed Hafiz Ali (C. P.).
32. J. S. Sangma (Assam).
33. B. C. Sarkar (Bengal).

MEDALS AND OTHER PRIZES.

Gold Medal to the best student of the year with Honours Certificate	Bhagat Singh (Punjab).
Silver Medal to the best student in Forestry	Suraj Mani Naithani (U. P.).
Do. do. in Botany	Ashutosh Sanyal (Bihar and Orissa).
Do. do. in Engineering	Bhagat Singh (Punjab).
McDonnel Memorial Medal (for the best Punjab or Kashmir student)	Ditto.
Fernandez Memorial Gold Medal (for the best student in Utilization).	Suraj Mani Naithani (U. P.).
William Prothero Thomas Memorial Prize (for the best practical Forester).	D. R. Bahrucha (Bombay).
"*Indian Forester*" *Prize* (for the best student who has got no other prize)	Bahadur Singh (U. P.).
Prize for Merit	Lal Singh (U. P.)

In conclusion, the Inspector-General of Forests addressed the students as follows :—

OUTGOING STUDENTS OF THE PROVINCIAL SERVICE AND RANGER CLASSES,

"Owing to the fact that up to last year each class had a separate prize-day, the number of occasions on which I have addressed forest students at the close of their training is considerable. I am afraid, therefore, that in the few remarks I have to make to you I may be repeating what I have said on previous prize-days.

"I am very pleased to hear the generally good report which the President has given of your work and progress.

"Notwithstanding the fact that the percentage of marks required for an Honours certificate in the Provincial Service course has been raised from 75 to 80, three students have obtained this distinction, and out of a class of 18 this is a good result. I wish particularly to congratulate the brilliant Madras student, T. V. Venkateswara Ayar, who heads the list of the Provincial Service class and who has established a record which it will be very hard for any of his successors to beat. I have also to congratulate the leading student of the Ranger class, Bhagat Singh, from the Punjab, as well as the Punjab and United Provinces Ranger students generally, for all three of the former and three out of seven of the latter have obtained Honours certificates. The two students I have named are the first recipients of the special gold medals given only to the head of each class, in place of the medals previously given to all holders of Honours certificates. They have every reason to be proud of the distinction they have earned and their careers will be watched with interest. Unfortunately the new gold medals have not been received in time to be distributed to-day.

"I am sorry to hear what Mr. Osmaston said about some of you being slack in taking part in the sports and games common to both classes. You are not marked for proficiency in athletics, which does not therefore affect the order in which you stand in your classes at the end of your training. But in the Forest Department, at any rate, much depends on physical fitness and

men who were good at sports and games in their school and college days sometimes have a pull later on in their service over those who failed to profit by the opportunities of this kind offered to them. I trust, therefore, that there will soon be an improvement in this respect: otherwise, I think, it may be necessary to devise a scheme under which the slacker at games will find that his want of energy does not pay him in the matter of marks.

"The next subject I have to refer to is, I fear, an unpleasant one. For the second time during the currency of the 1916—1918 course there has been a case of cribbing in the Ranger class examinations. On this occasion the culprit was not dismissed, though the action taken will make him regret his offence for some years to come. I wish to impress on you all that cribbing in examinations is one of the most dishonourable tricks that a student can be guilty of, and that the President, the Instructors and I are determined to put a stop to it. I warn you, therefore, that in future any student, Provincial or Ranger, Government or private, stipendiary or non-stipendiary, who is caught cribbing in examinations will automatically be dismissed.

"All of you who are now leaving Dehra stand on the threshold of your careers. You are joining a service which has not nearly reached full development and which, in future, cannot fail to be much larger and much more important than it is at present. You start with excellent prospects, for there is no doubt that the door to the advancement of the Indian members of the Forest Service will shortly be opened wider than it has been in the past. The extent to which you realize these prospects depends on yourselves only. If you work hard and intelligently you will get on well: otherwise you will not, and you will have no one but yourselves to blame if you are left behind in the race. Remember that to the last day of his service and to the last time he puts his foot in the forest there is always something more for the forest officer to learn. I wish you all possible success in your careers as forest officers."

The proceedings terminated with cheers for the Inspector-General of Forests, the President and the Research Institute and College Staff.

COMMERCIAL ASPECT OF THE FOREST DEPARTMENT.

BY C. W. ALLAN, RETIRED EXTRA DEPUTY CONSERVATOR OF FORESTS.

Mr. Watson's article on the above subject appeared in the double number of the *Indian Forester* for November and December 1917. By a happy coincidence "The Commercial side of Indian Forestry" happens to be in the same number. In it the true Commercial side is touched upon, and Sir Robert Carlyle is quoted as having said: "No business man would ever dream of developing a large business by starting in a small way, and setting aside, year by year, a small portion of his revenue towards extending it. He would either invest his own Capital, or, if he had not Capital, borrow it; and he had never yet been able to see why the Government of India should be in a different position in that respect from the business man."

Mr. Watson prefers to deal with the personnel of the Department from a similar stand-point, and finds it hard to see how the educational authorities of India are going to infuse the foresight, breadth of view and business acumen necessary for the proper management of a Commercial department to keep pace with the scientific training that Dehra Dun is hoped to give *within a measurable period.* In a sweeping way he thus condemns, with a stroke of the pen, the whole educational system of India and from such imperfect premises draws the deduction that "No business firm in the Indian Empire can foresee the time when it will be in a position to recruit in India a full staff, competent to manage all its spheres of activity." The argument is ingenious but unsound. For many instances can be quoted of great foresight and breadth of view as the result of training in India (Roorkee men in Egypt, etc., etc.). To quote the firms as preferring English Public school products, who naturally understand more about business coming from the centre of manufacture and supply, is to label the cause that deprived India of her home industries and stifled its potential wealth "business acumen."

Forestry is a practical science to be studied in the forests in all seasons, and the necessary stamina to stand the rigours of the

climate is more likely to be found in the country than out of it.

When the fact is fully realized that the Forester's life is more arduous and lonely than the average, the Department will get better leave and pension rules, meanwhile the Department ought to bring home to Government the desirability of separating the Scientific from the Commercial side and let sleeping dogs lie as regards the personnel.

BUSINESS OFFICE METHODS IN THE FOREST DEPARTMENT.

BY A. J. GIBSON, I.F.S.

Now that the value of the Indian Forest Department is being realized by consumers, a great expansion of its activities both on the commercial and the silvicultural side is to be foreseen, and it is very desirable that every executive officer should use his energies to the very best advantage in the next year or two. One has to admit that in India the immediate result of Government departmental activity is a firmer and longer acquaintance between the officers' and their office chairs. A Divisional Forest Officer thus immobilized is an officer off the executive cadre of the executive establishment, which is perhaps a trite way of putting it, but demonstrably true in any division where intensive silviculture waits on intensive utilization.

Office work is a necessary evil to be patiently (or otherwise) borne, but while silvicultural problems, better means of transport, conversion of forest products and so on command considerable thought that insidious sapper of energy and time—in which many typically Indian elements are engaged to neutralize attempts at improving matters, namely, "office work," has but scant attention. Yet in any commercial firm, office work, office equipment, office routine and labour-saving devices are given a prominent place in the programme of possible improvements and development and the Indian Forest Department, unless it accepts this view of the commercial world will be "left behind."

The whole system of disposing of letters and other written documents in Indian Government offices tends not to rapid handling and efficiency, but to multiplication of operations and, in consequence, what gladdens the heart of many, to increased clerical staff.

This is not an imaginary evil, but a very real one and it has to be fought and overcome if progress is to be made in handling an ever-increasing commercial and general correspondence.

The problem requires expert advice, or, at any rate, special knowledge or tuition. The writer has made a study of the matter for some eight or nine years, but so far with little success, for the very simple reason that up-to-date equipment is expensive, and the average stationery grant in a division inadequate. Government apparently does not mind spending money on men (an average division has five clerks costing Rs. 3,000 at least a year) but does very emphatically object to spending money on paper (Rs. 60 per annum seems to be an average divisional grant). The combined expenditure manages to deal with an average of not more than 6,000 documents a year or some 20 letters a day, plus accounts. A poor result. The average solicitor's office in London will deal with 100 letters a day with a clerk, lady typist and office boy or commissionaire. This is achieved by three means: the steno-typist, the type-writer and the "flimsy" carbon copy, together with a rational system of filing.

The unwieldy register of correspondence, the cumbersome receipts and issue numbering and case marks and the permanent laced file are things unknown, and cannot possibly persist if efficiency is to be the key-note of office routine. It is almost pitiful to see the attempts at précis writing in the prescribed register of correspondence. The results are useless as a rule, yet two clerks are fully occupied in posting it, if receipts and issues exceed about forty entries a day.

As for the prescribed method of recording and filing any system that ever existed has largely disappeared in most cases and now it just grows uncontrolled and generally not understood.

The vertical filing system, the loose-leaf ledger, a numer-alpha or other modern system of records, a card-index to keep abreast of matters in progress, are items in modern efficient office equipment which cannot be neglected much longer, and how to cope with his correspondence and yet leave the Divisional Forest Officer free for the bulk of his time to see to the silvicultural requirements of his forests is a problem that has to be tackled, and tackled soon.

At present this very important subject is left entirely to chance ; one hears of one Forest Officer who has two camp clerks and yet has to dictate letters while "tubbing" to keep top-dog over the pestilential bogey-beast that he himself has largely created, not without assistance from those who benefit most by the unhealthy propagation of the bogey, *viz.*, the hundred and one failed—something class, who must have Government jobs or die ; one also hears of another Forest Officer who serenely marks and thins and delves and inspects days on end and has no camp clerk at all. Where does the difference lie ? In organization and intelligent decentralization to some extent, but to a greater extent to the application, as far as is possible, of business methods in dealing with business correspondence, even though the department be a Government one. The ordinary forest office routine is amenable to organization, standardization methods and consolidation devices, all with the one object in view of getting the maximum work done for the minimum of correspondence, and the organizer who evolves a suitable system will earn the gratitude of many Divisional Forest Officers and as many harassed Range Officers, for it hits them hard too. Systematizing could be undertaken with the circle as the unit with such local variations as may be called for by circumstances in particular divisions.

This brief article is not meant to be a remedy for a very evil, but an attempt to draw attention to its very real existence. It is the powers-that-be who can apply the remedy. The most energetic tails created cannot impart sufficient impetus to the heads. Next Board of Forestry, Dehra Dun, kindly note !

XIMENIA AMERICANA, LINN.—A LITTLE KNOWN SPECIES.

BY C. E. C. FISCHER, I.F.S.

Probably few Forest Officers are at all well acquainted with this plant, which, however, merits more notice owing to several interesting characteristics. Cooke (Flora of the Bombay Presidency) describes it as "a small much branched spiny shrub," but in South India it is usually a large shrub attaining 15 feet in height and a girth of 4 or 5 inches. It belongs to the family *Olacaceæ* and, like several others in this Natural Order, is a root parasite.

The following is a brief description of its botanical characters :—

Bark dark reddish-brown, rough, with deep fissures. Branchlets often ending in spines. Leaves simple, alternate, entire, elliptic to suborbicular, rounded at both ends, glabrous, 1" to 2" long by ½" to 1½" wide.

Flowers in short racemes in the axils or at the ends of lateral twigs, fragrant, 4 or 5-merous, petals white, shaggy within.

Fruit an ovoid drupe, deep orange-red when ripe, ¾" to 1" long.

Wood yellowish-red, hard and heavy.

The young leaves when crushed emit an odour of bitter almonds. The pulp of the fruit has a pleasant taste, the kernel of the seed tastes like filberts and can be used for making a substitute for ghee. The wood is sometimes used by Brahmans on the East Coast in place of that of the sandal in religious ceremonies.

It is a plant of very wide distribution but apparently not very abundant anywhere. Outside the Indian Empire it is found in Ceylon, the Malayan Archipelago and in Tropical Africa and America. Within the Indian Empire it occurs in coastal tracts of Tennasserim and the Andaman Islands, in the Southern Mahratta country, Mysore and many districts of the central part of the

Madras Presidency. It has been reported from the following districts, and eventually will be found, in all probability, in others as well as in the Central Provinces and Hyderabad: Vizagapatam, Godavari, Kistna, Kurnool, Cuddapah, Chittoor, Nellore, Bellary, Anantapur, Salem, Coimbatore, South Vellore (North Arcot) and Madura and in the Bombay Presidency from Belgaum, Bijapur and Dharwar.

It has been found at elevations ranging from but little above mean sea-level up to 2,600 feet.

Talbot gives the flowering season as January and May for the Bombay Presidency.

My own observations in the Madras Presidency are :—Flowers November to March, fruit May to September, and I once found unripe fruit in December.

The following vernacular names are derived from my own notes and from the following works: Gamble's "Manual of Indian Timbers"; Brandis' "Forest Trees"; Cooke's "Flora of the Bombay Presidency"; Talbot's "Forest Flora of Bombay"; and A. W. Lushington's "Vernacular List for the Madras Presidency."

Burma :—*Pinlé Kazin*, *Pinlé Zi*. Kanarese : *Nekri*, *Nakkarai*, *Kandarakkarai*.

Telugu :—*Uranechra*, *Uranakkera*, *Kondanakkera*, *Nagaragandanam* (Nellore), *Naggiri* (Chittoor).

Tamil :—*Chiru-Illantai*, *Siruyilandai*, *Kadaransi*, *Kattanji* (Javadis), *Shenkarai* (Walayar), *Madukarai* (South Coimbatore).

Rampa :—*Kakira*.

The haustoria in *Ximenia* are of considerable size, very much larger than those of *Santalum Album*. They are often formed on its own roots and frequently lead to the complete fusion of the two root branches concerned. The parasitism of this species has been studied by Dr. C. A. Barber, D. Sc., but unfortunately the results have not yet been published.

In a part of Mysore the local population make use of the kernels of the fruit to manufacture a substitute for ghee. The kernels being extracted are crushed and boiled in water The floating oil is skimmed off and cools down to a substance resembling ghee and is used for the same purposes.

A preliminary study of the root-nodules of *Casuarina*.

Photo-Mechl. Dept., Thomason College, Roorkee.

Fig. 1.—Root-nodules of *Casuarina glauca*.

Fig. 2.—Root-nodules of *Casuarina*: a large cluster from a tree near a tank.

The plant probably is not found growing naturally in sufficient abundance to support an extensive industry, but there should be little difficulty in propagating it should it hold out promise of successful development. Several points would require preliminary study, especially the degree of parasitism of the plant and how far it can thrive "on its own."

A PRELIMINARY STUDY OF THE ROOT-NODULES OF CASUARINA.

BY M. J. NARASIMHAN, B.A., JUNIOR ASSISTANT MYCOLOGIST, AGRICULTURAL DEPARTMENT, BANGALORE.

(Abstract of a paper read before the Indian Science Congress held at Lahore in January 1918.)

Introduction.—The Casuarina has been very successfully cultivated in Southern India on many of the wild waste lands. It thrives well on poor sandy soils, as can be seen by the great luxuriance with which it grows along the sea-coast on the sands, as, for instance, in Madras. According to Gamble (3) it has been very successfully introduced along the coast from Madras to North Canara, especially near Nellore where the Casuarina aids in preventing the shifting sands from encroaching on the cultivated lands. In Mysore, too, on the Talkad sand-dunes the Casuarina has been introduced to bind the shifting dunes, which have been reclaimed in so successful a manner as to make it possible to grow sandalwood trees between the rows of Casuarina. Though Casuarina grows very well on ordinary soils, at higher elevations as in the Bangalore and Tumkur plantations in Mysore, it is indigenous to sandy soils on the sea-coast. Brandis (2) reports the distribution of Casuarina on "Sandy hills on the coast of Chittagong, Tenasserim and the Andamans." In short, the natural home of Casuarina is the sandy sea-coast.

The root-nodules of Casuarina were observed by the writer during December 1909 along the Madras coast, and were again met with in very large clusters, while engaged in digging the haustoria of sandal feeding on Casuarina roots in Bangalore. As

far as can be ascertained by studying the literature on the subject of root-nodules, no adequate mention of their presence in Casuarina has ever been made. The credit of making the first report, however, goes to Dr. Barber (1) who says "that the Casuarina roots examined in the two Bangalore plantations are badly affected by a disease resembling that of the well-known alder root-tubercles." The above-quoted words give the impression that the relation between the Casuarina plant and the nodular organism is one more of a parasitic nature than beneficial. The physiological rôle of the root-nodules in relation to Casuarina trees seems, in the present writer's opinion, to be of a more beneficial kind than the above-quoted words seem to imply.

Root-nodules were also obtained from a small tree of *C. glauca* growing in the compound of the Bangalore Agricultural Laboratory as well as from seedlings of *C. stricta* and *C. quadrivalvis,* growing in Lalbagh, Bangalore. Though other species of Casuarina have not yet been examined, it may be safely assumed that the possession of root-nodules is a marked character throughout the genus.

The Casuarina nodule is a cylindrical body, with a slightly swollen hyaline tip; the young nodule is whitish but later on becomes brown and more or less woody. Some of the nodules of *C. glauca* were flesh-coloured. By repeated branching of the nodules, a cluster is formed which attains a fairly large size (Fig. 2). The formation of the nodules begins at a fairly early stage in the life of the plant. Seedlings* of *C. equisetifolia* four months old show small swellings here and there, and in less than seven months, a small nodule cluster is formed.

When a nodule is thoroughly washed and crushed, a whitish slimy juice oozes out which, when examined, shows rod-shaped organisms embedded in a mass of gummy substance. These organisms can be better made out in thin sections of the nodules

* In this connection it is interesting to find in the *Journal of the Madras Agricultural Students' Union*, January 1918, an article by Mr. Jogi Raju who states that it is a common practice in Vizianagram to remove the "gall-like outgrowths" from the seedlings before they are planted out.

A preliminary study of the root-nodules of *Casuarina*.

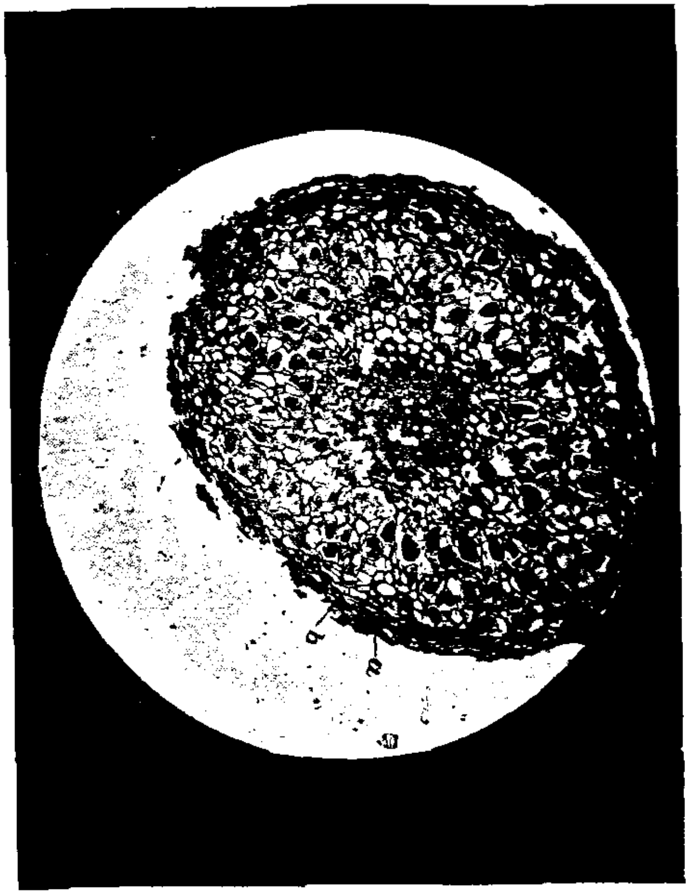

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 3.— Transverse section of a nodule. Bacterial cells, dark and large-sized overstained for taking a photo.

a............cork cells : *b*..... ......bacterial cells.

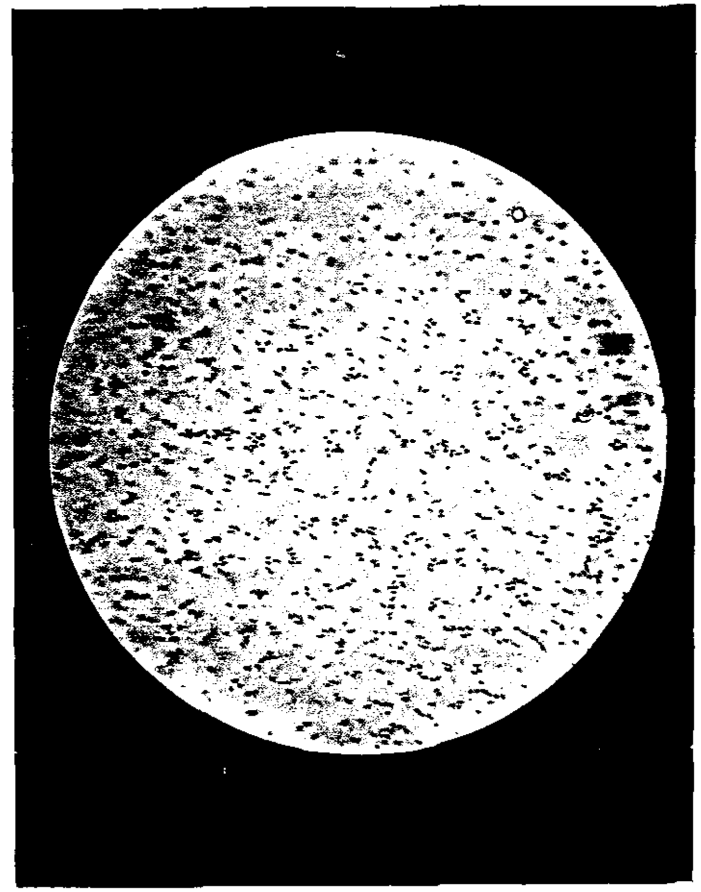

Fig. 4.— Micro-photograph of bacteria from culture.

(Fig. 3). The cells inhabited by the bacteria are larger in size than the surrounding cells and their nuclei often assume fantastic shapes.

The bacteria stain well with the amylgram stain, which was supposed by Harrison and Barlow (4) to be characteristic of the bacteria in the leguminous nodules.

Pure cultures of the bacteria were obtained, which appeared as glistening, musilaginous colonies. The bacteria thus obtained react in the same way as those inhabiting the nodule, when stained with amylgram stain. When grown in a liquid media free from nitrogenous salts, the bacteria of the Casuarina nodule were found to fix the atmospheric nitrogen. Estimation of the liquid media by the Kjeldahl method, thirty-five days after the culture was made, showed an increase of 2·7 m. g. of nitrogen per 100 cc. of the liquid.

Further work has yet to be done in the direction of inoculating Casuarina seedlings grown under aseptic conditions with the bacteria obtained in culture to see if nodular formation can be induced.

Conclusion.—Apart from the usefulness of Casuarina trees in binding sandy soils, it is not difficult, in the light of this preliminary study, to conclude that the sandy soils are actually improved so as to afford facilities for the succession of the inland flora. In connection with reclamation of the sandy sea coasts, Gamble (3) says: "Once reclaimed the coast lands get easily covered with shrubby and tree vegetation; and other trees which would have been difficult to plant at first can be easily brought in and a permanent forest constituted." The exact way in which the soil condition is improved is a problem still awaiting careful research.

The detailed results of this investigation will be embodied in a bulletin of the Agricultural Department, Mysore State. In conclusion the writer wishes to express his acknowledgments to Dr. Coleman, Director of Agriculture, Bangalore, for his kindness and sympathy during the investigation. Thanks are also due to Mr. M. O. Thirunarayanan, Assistant Entomologist, Sanitary Department, Calcutta, for the help rendered in collecting the material.

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2. Brandis ... ... Indian Trees.

3. Gamble, J. S. ... A Manual of Indian Timbers, 1902.

4. Harrison and Barlow ... The Nodule Organism of the Leguminoseæ. Centraiblatt, f., Bakteriologie, 2, Bd. 19.

EXPLANATION OF FIGURES.

Plate 15—

Fig 1. Root nodules of *Casuarina glauca* from a seedling.

Fig. 2. A large cluster of nodules.

Plate 16—

Fig. 3. Micro-photograph of a transverse section of a root-nodule : (*a*) cork cells, (*b*) bacterial cells.

Fig. 4. Micro-photograph of bacteria from pure culture.

ANJAN (*HARDWICKIA BINATA*) COPPICE.

BY H. W. STARTE, I.F.S.

The unsatisfactory coppicing power of Anjan is well known, and it has been said that some 40 per cent. of Anjan stools fail to produce coppice shoots; and that moreover this failure is irrespective of the girth of the felled tree.

In January 1917, the Inspector-General of Forests inspected the forests of the North Khandesh Division, Bombay Presidency, and at his suggestion two investigations have been started in the pure Anjan forests of Shirpur East Range, *viz.* (1) to obtain further details regarding coppicing; and (2) to find out whether better results cannot be obtained by pollarding at 6", 12" or 18" from the ground; and also which month of felling is best from the point of view of reproduction. As Anjan is chiefly grown for fuel here, pollard shoots will be as useful as coppice shoots. Observations under the first head are completed, and details are given below:—

An area of 10 acres of pure Anjan forest growing on typical Anjan soil was selected in coupe No. 18, Block III, Shirpur East

Range, which was under exploitation last season, and every stool (886 out of 896 were cut level with the ground) has now been examined. 201 have failed to coppice, *i.e.*, 22·4 per cent. The details are as follows :—

Girth at ground-level, in inches.	Total No. of stools.	Successfully coppiced.	No. of failures.	Percentage of failures to total stools.
12–18	283	242	41	14·4
19–24	320	251	69	21·5
25–30	116	81	35	30·1
31–36	82	60	22	26·8
37–42	35	24	11	31·4
43–48	36	21	15	41·6
49–54	8	6	2	25
55–60	11	7	4	36·3
61–66	2	2	...	...
67–70	3	1	2	66·6
71 and above	...	...	...	...
Total ...	896	695	201	22·4

It therefore seems that the percentage of failure has hitherto been put rather too high, but that, as formerly stated, there is little correlation between girth and coppicing power.

It is hoped to give the results of the second series of observations later.

THE MADRAS BOARD OF REVENUE AND SCIENTIFIC FORESTRY.

Forest Officers in other parts of India have often thanked their stars that they do not have to serve in Madras under the Board of Revenue. This august, if somewhat turgid, body has recently given fresh reason for this feeling of thankfulness in their Resolution Forest No. 136, dated 31st August 1916, published at page 86 of the "Working Plans sanctioned by the Board of Revenue during the year 1916." The Board have duly considered the Working Plan for the supply of fuel to Madura town drawn up by Mr. C. C. Wilson, Deputy Conservator of Forests, and in the following stately words is their decision announced :—

"Mr. Wilson's estimate of 60,000 tons as the annual demand of Madura town in the matter of fuel accords fairly well with the estimates which have been previously made by Mr. Scot and other officers and may be accepted. No information is available as to the proportions in which the supply is used for domestic and for industrial purposes; but the Board, after discussing the question with Mr. Wilson, is inclined to think that at least 50 per cent. of the supply is required for industries.

"The supply is at present obtained from the following sources :—

	Tons.
From Madura Government forests	12,000
" Trichinopoly "	11,000
" Private sources	37,000

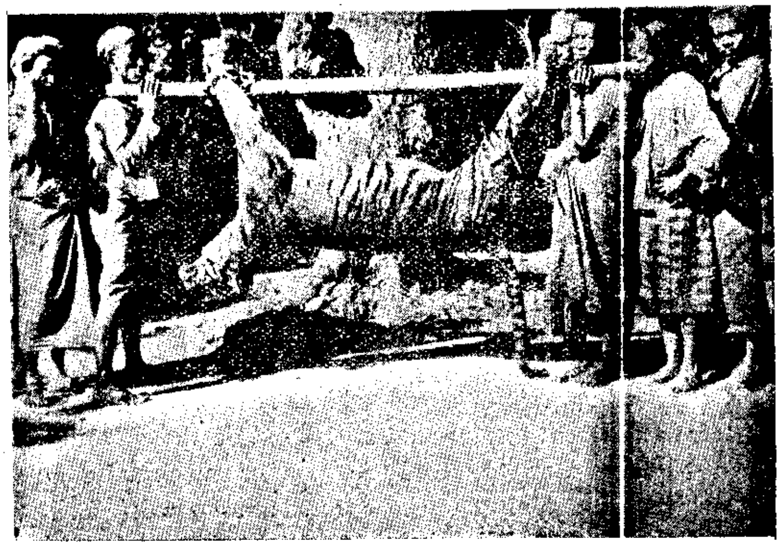
and it is expected that the Government supply can be increased to 35,000 tons (20,000 from forests under the present plan, 11,000 from Trichinopoly forests, and 4,000 from the Palni slopes), which will still leave 25,000 tons to be supplied from private sources. It is an undoubted fact that the private forests in the two districts are being ruthlessly destroyed, and that the supply of fuel from them will diminish steadily and may, in the course of the next ten years, fail altogether. It is probable, therefore, that at the end of this period not merely the town of Madura but the whole

district will be mainly dependent on the Government reserves for the supply of wood fuel. In fact, a fuel famine is threatened, and in order to mitigate its effects, the suggestion is made in the plan that Eucalyptus plantations should be started at once on the Palnis, if it is found possible to bring the wood down to the markets in the plains at a reasonable cost. The Board is unable, however, to approve of this proposal. In the first place, the policy of Government, as enunciated in their order on the Forest Committee's report, is opposed to the maintenance of fuel plantations by the Forest Department, for the reason that the establishment of such plantations may be safely left to private enterprise. In the case of Madura it may be expected that when the price of fuel begins to appreciate, either private enterprise will step in to raise Casuarina plantations along the coast, or the demand for wood will be reduced by the use of other forms of fuel, especially for industrial purposes, or both. Again it must be remembered that a fuel famine threatens Madura district and not Madura town alone, and that the plantations would have to be established on a gigantic scale if the price of fuel is to be kept down to anything like the present figure. The Board considers that the Forest Department cannot possibly undertake the task and that its obligation in the matter of fuel supply is limited to organizing and working to their fullest possible extent the fuel forests which are under its control."

As it is an undoubted fact that the private forests are being ruthlessly destroyed, and that the supply of fuel may shortly fail altogether, is it possible for any reasonable man to maintain that "it may be expected that when the price of fuel begins to appreciate, either private enterprise will step in, or the demand for wood will be reduced by the use of other forms of fuel." If the native owners will not now make the slightest effort to work their forests on any rational system, can one expect that they will later on embark on the large and expensive operations necessary to form new forests? Also, what fuel is likely to take the place of fire-wood in this part of the country? presumably the sun's heat or nitrogen from the air in some form. Can the Board

honestly say that "the establishment of such plantations may safely be left to private enterprise"? The last sentence but one is also a gem. As the fuel famine seems to be threatening on a very large scale, it is of no use for Government to attempt to undertake measures which would help to alleviate a part only of the distress!! It seems incredible that the Board can shirk their responsibility in this way, and that, after plainly saying "a fuel famine threatens Madura district," they can calmly decline to help in any way to provide the population with a necessity of everyday life. The pompous and empty secretariat phrase "The policy of Government, as enunciated," and so on, is a dreadful example of how an ignorant bureaucracy treats matter of the greatest importance for the welfare of the population of the country. The Conservator says: "the only feasible system of making up the balance (of 25,000 tons) seems to be to increase our Eucalyptus plantations." By refusing to make plantations and to obtain some sort of control over the private forests, the Board seems to be guilty of a most remarkable neglect of duty and of the advice of their scientific advisers. Heaven preserve us from the Madras Board of Revenue!

JOHN COMPANY.



THET HNIN'S STORY CONCERNING A TIGER.

"The night holds many terrors for us all."—*The Author!*

The animal that loves the night, sulks in the shadows by day and to all is the hall-mark of ferocity. Few, however, conceive the diabolical cunning this animal is capable of. With this preamble let Thet Hnin tell his own tale :—

"In the month of January when the crops are reaped but the paddy has not yet left the threshing-floors, myself (cultivator, aged 48), my wife (Ma Ke, aged 35), and our little daughter, aged 3, had all retired for the night on the ground under our hut in the fields—on the ground, I say, to be nearer our precious store of a year's sustenance in the paddy that lay collected at the threshing-floor but not yet "binned."

My wife and little daughter nestling by her bosom were asleep. I feel sure, but I lay smoking the pipe of peace in the shape of a white torch of the country, in contemplation of the day's doings, when lo! with less warning than a thunder-clap, there is a scuffle beside me and my scattered senses are numbed by the fact that my wife is gone in the deadly grip of a tiger!

I stand stupefied for an instant and my wife, doubtless temporarily released from the relentless hold, calls out "Oh mother." There is a loud thud and all is quiet again.

That haunting thud that rings in my ears by daytime and its memory the sole companion of my nightly sleepless vigil, Poor Ma Ke. A good and faithful wife, and mother of such a bonny wee daughter. To think that I was powerless to help and too horribly mortified with fear for the dear soul that was left to me. Clutching her up in my arms my mind does not record the route I took to the village, nor, arrived there, what I said. For the rest of the night my body shook as with a palsy and my palpitating brain felt confined in a shrunken skull.

I have a dim recollection of a movement of the whole village at dawn to the scene. Arrived there, after much noise on the way, the ghastly remains of my wife were seen a "call" from the hut, lying in a waste patch of thatching grass, with ample evidence of two freshly vacated lairs! The upper trunk of the body, with arms, neck and head, was all that was left (also the feet). The head was hairless and bereft of flesh and skin! The drag-trail showed clearly the pugs of two tigers, the smaller one carrying the woman and the larger just following alongside.

I conclude that a tigress having taught her vile cub the way to kill stood by and witnessed the foul deed enacted and then formed up as an escort. Innumerable fang marks were found on the poor woman's neck. To release its hold for a rest then ferociously seize hold again explains the wail of the dying woman and the ominous thud alluded to in the beginning."

So ends a ghastly narrative which is verified by all the village elders as it happened but a short while back.

The figure on the preceding page is of a very old tigress shot while returning to her kill of a wild ox. May the hand of the Shikari never falter in its steadiness in the destruction of such brutes!

KAI HTUN.

A FEW NOTES ON *HOPEA PARVIFLORA.*

BY C. KARUNAKARA MENON, FOREST RANGER, COONDAPUR, SOUTH CANARA, MADRAS.

This tree belonging to the natural order *Dipterocarpeæ* is one of the most important species on the West Coast. Though it deserves a place second to none among the timber species next to Teak, Rosewood and Vengai, literature on this species is very scanty. Even the Manual of Silviculture for the use of Forestry students in India does not make mention of this important timber tree in the list of the "most important trees of the west coast zone." Such authoritative works as Gamble and Bourdillon give it only a passing reference.

One of the most important species in the forests of South Kanara is *Hopea,* which is of great commercial value. In the course of my tours as a Forest College student, I saw this tree in the forest of South Malabar and in the evergreen forests of Tinnevelly—but nowhere in these places did I find it so abundant as in South Kanara, which seems to be its natural habitat. My experience in South Kanara is confined only to two Ranges Shankranarayana and Coondapur and that too only for a short period of six months.

This district has a damp warm climate and a heavy rainfall which seem to be its essential requirements, inasmuch as it is seen on any kind of soil—from fine deep soil down to hard or semi-permeable laterite, but not on sandy soil; only with this difference that in proportion to the depth and moisture, absorbing qualities of the soil is the growth in height and girth of the tree.

Natural regeneration under mother trees is excellent. Under some trees and in the neighbouring areas the growth of seedlings is so thick that a handful of sand thrown from above, would be prevented from reaching the ground by the fine matting of these seedlings. Any attempt at raising plantations is bound to meet with failure. Broadcast sowing has satisfactory results. Saplings which are the results of broadcast sowings done in Coondapur Range some seven years back, left undisturbed

without being weeded or cleaned, grew peacefully under shade and are fine ones now, though a good percentage have died out and disappeared as completely as young Teak would do under such circumstances. I measured a few in some places and the biggest one gave a height of 16 feet and a girth of 5 inches. At this stage or two or three years earlier they must be freed, light let in and branches pruned. This would considerably help them to grow into straight fine poles.

The seedling crop requires the complete removal of the lower canopy of evergreen growth usually found in these forests. Later on the high canopy should be opened. Any attempt at clearing or weeding in the very early stages is detrimental to its interest in the case of sowings made in open areas in coupes worked under the method of coppice-with-standards. For by this operation we would only be reducing the percentage of successful growth by exposing it to light which nature itself tells us is not favourable to its growth in its early stages. This is borne testimony to by the fine growth of Kiralbhogi patches in a portion of the forests frequented by Foresters.

A fine Kiralbhogi area of about 40 acres is now found in Madibare Timber Working Circle in Coondapur Range in which it is proposed to carry out improvement fellings. In some of the forests worked under the method of coppice-with-standards in North Mangalore Division, the percentage of Kiralbhogi growth is not so much as it was before, and in the absence of adequate staff the only method left for its propagation is to carry on broadcast sowings throughout the coupe in the year in which a coupe is felled.

It seems to me that coppicing will not result in success. In Shankranarayana Range, North Mangalore Division, Coupe No. I of Sabladi Reserve is under felling; the stumps of Kiralbhogi trees cut are coppiced. Observations will be made on this point and published in these pages.

Regeneration from mother trees is aided by the fact that the tree seeds annually and the seeds fall only at the end of May when the fire season will be over. Since it has a tendency to grow

gregariously in patches, the question of the exploitation of mother trees without detriment to the undergrowth is a difficult problem. Clear felling and then sowing the area is out of the question, inasmuch as the seedlings require shade in the early stages.

Previous to reservation, accessible parts of the South Kanara forests must have seen a lot of hacking and a lot of this useful timber must have been removed. In meeting the exigencies of the anticipated timber famine, Kiralbhogi will play a conspicuous part. Simultaneous with its exploitation its propagation must be assured and for this one feasible course is to select all areas in accessible forests with Kiralbhogi mother trees as overgrowth and its seedlings and saplings as undergrowth; to make other areas inaccessible accessible; carry broadcast sowings around such areas and gradually by annual sowings get the Kiralbhogi area extended and exploit the mother trees without further delay.

A SUGGESTION.

Why should not the principles of marking according to particular silvicultural systems be taught to forest students and marking officers by means of small scale models of the forest under treatment, the trees being removable? This would stimulate the imagination as to what the forest looks *as a whole*, before and after markings, in a way that field practice can never do owing to the restricted range of a marking officer's vision.

The models would have to be fairly realistic reproductions of the forest concerned, with trees of all sizes, species, and typical shapes found in the original. Measurements could be taken with miniature callipers or, if this were not convenient, marked on the model trees. Construction would certainly be laborious, but should not, I imagine, present any insuperable difficulty at any institute employing an artist and skilled artificers.

Doubtless the idea is not novel, but I do not personally remember to have heard of its being put into practice.

J. N. OLIPHANT,

D. C. Forests.

[We think Mr. Oliphant's suggestion an excellent one and propose to act on it. If carefully carried out it should be both interesting and instructive—HON. ED.]

THE AWAKENING OF THE GOVERNMENT OF BURMA.

From the following extracts from the speech made by the Revenue Secretary at the meeting of the Burma Legislative Council held at Rangoon in March 1918 Forest Officers are encouraged to hope that the importance of the forests is becoming realized and that the department may look forward to a new era, in which money will be available for at least the most ordinary necessities, and that the days of the old *regime*, when the Forest Department was regarded in many ways as the goose that laid the golden eggs, are over :—

Extracts.

The Hon'ble Mr. Keith in presenting the revised financial statement for 1918-19 to the Council said: Like its three predecessors, the statement assumes the continuance of the war. * * * * Our receipts were 32½ lakhs more and our expenditure 15 lakhs less than the budget estimate, and we closed the year with a provincial balance of 117¾ lakhs, or 61 lakhs better than we anticipated. The bulk of the substantial increase in the receipts came from our forest revenue which, thanks to a favourable combination of circumstances, exceeded all anticipations and was the highest ever known. * * * * I now come to the estimates of the current year. * * * * We expect our forest revenue to be 10 lakhs better than the budget figure. * * * * Forest expenditure is expected to be a lakh and a half above the budget estimate owing to a change in the procedure adopted for paying the contractors employed in the extraction of timber in the areas under departmental working. * * * * I come now to the budget estimate for 1918-19. * * * * From our forests we look to receive a total revenue of 119 lakhs, or only one lakh less than the revised estimate.* * * * Under forests we allow for an extra expenditure of two lakhs which is accounted for wholly by the increased allotment for extraction by departmental agency. The provision for forest roads and buildings, 3¾ lakhs, is 72 per cent. more than the actual expenditure in 1916-17 and nearly a lakh greater than the revised estimate for the current year. The allowance of 2¾ lakhs for the

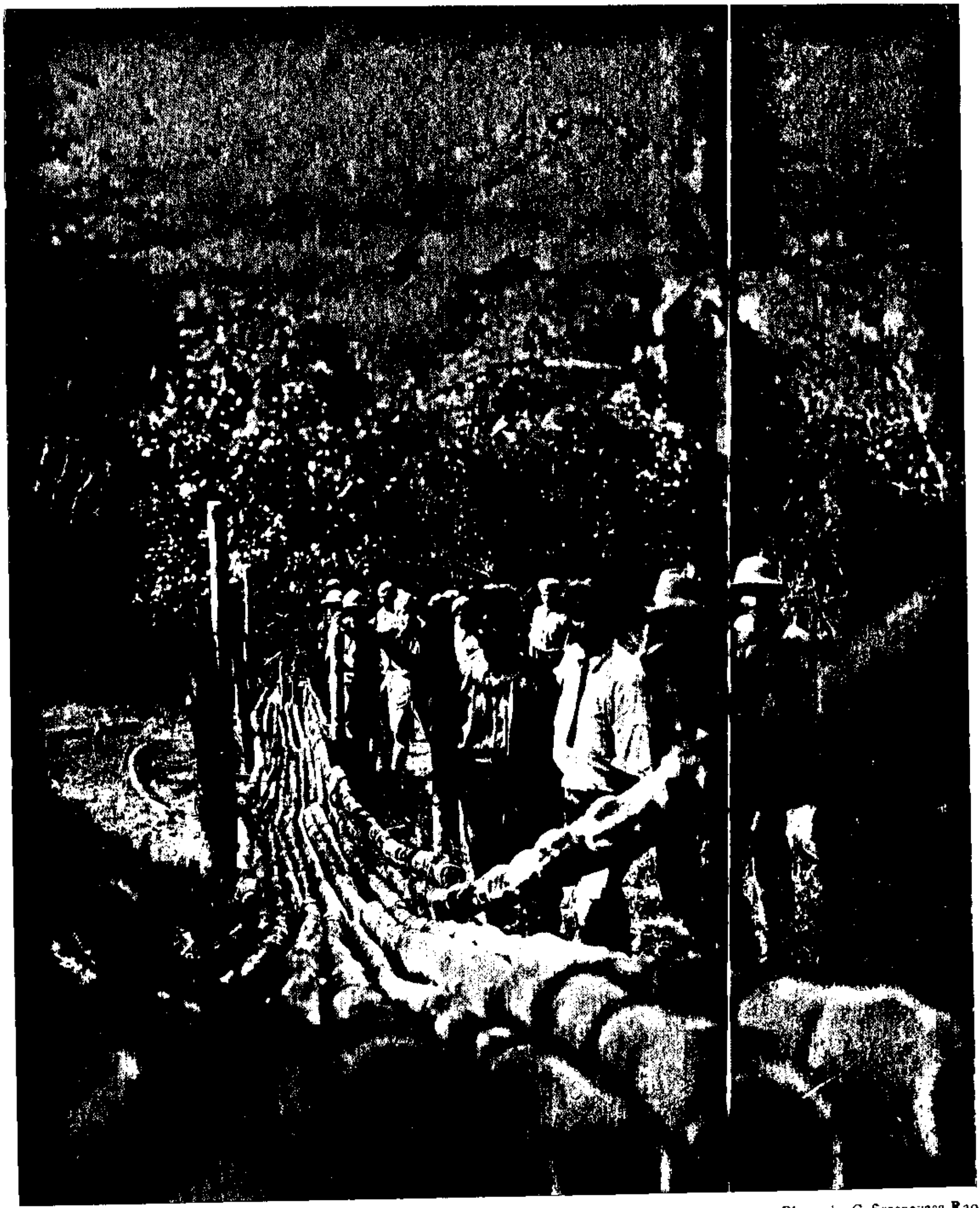


Photo-Mechl. Dept., Thomason College, Roorkee. Photo. by C. Sreenevasa Rao.

A FUEL SLIDE.

purchase of stores, tools and plant, and the purchase and keep of Government elephants is a lakh in excess of the expected expenditure of 1917-18. In all, the provision for conservancy and works is $5\frac{1}{4}$ lakhs more than the actual expenditure in 1916-17. Large though this increase is both relatively and absolutely, we recognize that our total expenditure on forest conservancy and work is very inadequate and that a much larger outlay is essential for the proper working and development of our forests. Proposals for a substantial enlargement of the forest establishment will shortly be submitted to the Government of India, and it is hoped that as a result of the revision of the financial arrangement between the Imperial and Provincial Governments which were foreshadowed in the speech of the Hon'ble the Finance Member of the Government of India, this province will, before long, be in a position to take its proper place as one of the principal timber exporting countries in the world.

EXTRACTS.

A NEW SYSTEM OF TIMBER EXPLOITATION.

TO THE EDITOR, "PIONEER."

TIMBER EXPLOITATION

In a series of articles published in the latter half of last year on the commercial side of forest work in India we took occasion to criticize the present system of selling standing trees to purchasers, largely for the reason that Government loses a considerable portion of the revenue it might otherwise obtain from its forests. Government forests are the property of the State and the tax-payer is justified in demanding that they should be worked to produce as large an income as possible. There is also another aspect of the question which demands attention. Government is itself a very large purchaser of timber, particularly in the Railway Department and it is obvious that it should be in a position in some measure to control the market and to insure itself against having to pay enormously inflated prices for its requirements. It can do this only by extracting a considerable portion of the timber by its own agency. Since the beginning of the war, owing to the restrictions of imports, there has been to some extent a timber famine in this country. The shortage has recently been intensified by the enormous demands made by the army for timber for military purposes and prices have soared beyond anything contemplated a year or two ago. The amount of timber now being marketed by the Forest Department is small compared with that belonging to private traders, and it is the latter who are making big profits. In fact, we are faced with a most unsatisfactory state of affairs. Government is paying famine prices for timber which has come out of its own forests, for which in many cases it is not receiving one anna extra in the shape of increased royalties, owing to the forests having been leased for a term of years at rates ruling before the war. It is hoped that the lesson now being learnt will in due

course bear fruit and that Government will realize the unwisdom of allowing the exploitation of its forests to pass almost entirely into the hands of private timber traders.

In our previous articles we suggested that if departmental works were again to be undertaken, it would be impossible to expect the existing staff, who are already fully occupied with other work, to find time for their supervision. It would be necessary completely to reorganize the Forest Service into three distinct branches. The first, which would consist of the present establishment, would conserve the forests and grow the raw material; the second would take the timber to the market, while the third would be concerned merely with marketing the produce. The chief argument against departmental working is that it is not the function of Government to enter the market as a timber trader at the expense of private enterprise. Partly to meet this argument, Mr. Parnell, writing in the July number of the *Indian Forester*, outlines a system of exploitation which he maintains would encourage private enterprise in the timber trade and at the same time enable Government to retain a complete control over its timber. Other advantages claimed for this system are that it would give Government a fair share of the profits, and would obviate the necessity of establishing a new branch of the Forest Service. The scheme, says Mr. Parnell, was suggested to him by a member of one of the large firms of forest lessees in Northern India. To put it briefly, the suggested system provides for utilizing existing firms of timber merchants to exploit the forests on a profit sharing basis. Work would be carried out very much as it is at present. The firm would fell the trees, convert them into timber and deliver the timber at the market; it would employ its own staff of managers, assistants, etc., and would provide the capital required for the work. It would also give expert advice as to marketing the produce. The essential difference from the present system of working would be that until the timber was sold at the depôt, it would remain the property of Government. At the end of each working season accounts would be prepared showing the expenses incurred both by the firm and by the Forest

Department and the revenue obtained from the sale of timber. To the expenses incurred by the firm would be added interest at a fixed rate per cent. on the money they had expended. A balance-sheet having been prepared, Government would refund to the firm the money expended by them, plus the interest thereon, and would, in addition, give them a proportion of the profits.

There are two very obvious difficulties standing in the way of the introduction of this system. The first is to assess the rate of interest to be paid on the capital invested, the second to decide on the division of the profits. With regard to the former, Mr. Parnell suggests that it should be fixed at the rate of interest at which Government can borrow money in the open market. But the majority of timber traders do not possess sufficient capita of their own to finance works of this description, and if they borrow from a third party, they cannot obtain the money except at high interest. Mr. Parnell anticipates, however, that at least one or two firms could be found in each province who possessed sufficient capital of their own, and he suggests that the whole of the work should be given to such firms. The objection to this is that the few richer timber traders would reap all the benefits, while many men who now do a large share of the work would go to the wall. The proportion of profits which would be paid to the firm would be in return for their trouble in management, for their expert commercial advice and generally as remuneration for their work. Discussing what would be a fair amount to pay them, Mr. Parnell observes: "In view of the fact that Government would be paying a fair rate of interest on outlay each year, ... it would not be necessary to guarantee the firm any exorbitant share of the profits. However, what would be considered a good return from an investment in Europe, would hardly be so regarded in India by the ordinary commercial man, so that the share of the profits could not, in all probability, be pitched very low." He suggests, therefore, that 10—12½ per cent. should be used as a basis of discussion.

Mr. Parnell then details an imaginary account for the working out and sale of the outturn of 10,000 deodar trees, in which it is

assumed that Government pays the firm 5 per cent. on their annual outlay and that the firm takes 10 per cent. of the excess of receipts over expenditure. The accounts show that for an expenditure of roughly 6 lakhs the firm gets roughly $1\frac{1}{2}$ lakhs return (interest on outlay, plus share of the profit) while Government gets a royalty of about Rs. 104 per tree: at first sight a highly satisfactory result. Mr. Parnell admits, however, that his account is optimistic. We should be inclined to call it Utopian. We have yet to hear of the division in which the forests yield an average of 50 broad gauge sleepers per tree and from which the sleepers can be landed at the depôt for less than a rupee. If such forests exist, we imagine that Government would have little difficulty in obtaining Rs. 104 for its trees under the existing system, so that Mr. Parnell's contention that his scheme would give Government a larger share of the profits is hardly borne out by his " theoretical " account. It would have been more satisfactory and would have greatly enhanced the value of his proposals had Mr. Parnell obtained from the member of the firm, who suggested the scheme, detailed figures as to expenditure and outturn for one season of the firm's working, and based his account on these data.

Apart from financial considerations, we consider that the scheme suggested is unnecessarily complicated. Assuming that private enterprise must be encouraged and that existing timber traders are to be used to exploit the forests, it would be far simpler to employ them as managing agents working on a commission basis. Government might advance them the money for carrying out the work, and the firm would be responsible both for the exploitation and for the marketing. In addition to the actual expenses incurred on the work, allowance could be made for interest on the capital employed at current rates, and at the end of the season the accounts would be made up and the firm paid a percentage on the profits. The suggestion that the Forest Department should employ managing agents to bring its produce to the market was put forward by our Calcutta correspondent about a year ago, and as an alternative to the department exploiting the forests itself it is a proposal worthy of consideration.

TO THE EDITOR, "PIONEER."

DEAR SIR,—May I ask for space to reply briefly to the article on "Timber Exploitation," which appeared in your issue of the 17th August.

I admit that my estimate of 50 B. G. sleepers per tree is somewhat Utopian, though I think perhaps it has not been fully realized by my critic that I am dealing in my account with trees 30″ *and over in diameter at breast-height.* I have no objection whatever to reducing my figures to 40 B. G. S. per tree. I will also raise my rate for conversion to Rs. 37½ per cent. sleepers. Allowing for a few minor modifications, all in favour of the expenditure side, I will revise my account as follows :—

	Rs.	a.	p.
Firm's expenditure	5,40,000	0	0
Government's expenditure (including interest on firm's outlay Rs. 27,000)	77,000	0	0
	6,17,000	0	0

Gross receipts on 3,50,000 B. G. S, say, Rs. 14,67,000. Even then a ten per cent. share of profits, plus interest on outlay, gives the firm a return of over 20 per cent. : while Government receives royalties at the rate of Rs. 76½ per tree. A 20 per cent. return would probably be acceptable to firms of good standing even in India : while it is believed that the royalties would be quite 25 per cent. higher than those obtained at present under the system of selling trees standing to lessees.

As regards cost of delivery, my revised estimate is :—

Conversion ...	6 as. per sleepeer	Rs. 1-3-0 per sleeper or say Re. 0-5-5 per cubic foot.
Carriage to river ...	6 as. " "	
River transport ...	6 as. " "	
Handling in Depôt ...	1 anna "	

One of the objects of the scheme outlined by me in the *Indian Forester* was to get Forest Officers into close personal touch and relationship with the timber trade : another was to encourage the investment of money by the public in the timber trade, and to avoid the direct outlay of large capital sums from Imperial revenues. It

is doubtful if either of these objects would be attained by the employment of "managing agents" as suggested in your article.

Finally, my remark in my original article that the scheme "was suggested by a member of one of the large firms of forest lessees . . . ." is perhaps misleading. If I remember aright the gentleman in question considered that a *half share of the profits* should be paid to the firm (not merely a 10—12½ per cent. share as I have tentatively suggested.). Under the circumstances I must shoulder the whole responsibility of the scheme with all its shortcomings.

Apologizing for the length of this rejoinder.

R. PARNELL.

CHANGLAGALI, N.-W. F. P.
22nd August 1917.

THE WALNUT TREE.

It is rather sad news to the tree-lover to hear of the felling of walnut trees in England for use in aeroplane construction, the finely-grained wood being both hard and light—just as in the Peninsular War the same tree was extensively cut down to make musket-stocks, since when it has been much less common in this country. The walnut is lovely and pleasant in its life, from the time it unfolds its coppery leaf-buds and hangs out its long, handsome catkins through its summer of apple-scented (when bruised) foliage and swelling green fruits to its ripe nuts in October—which, it may be remarked, should be eaten now, as they are more wholesome and digestible than when quite new. A mature tree may produce from two to three thousand nuts, but they do not usually ripen properly in Great Britain, except in the warmer parts.—[*Timber Trade Journal.*]

THE SHRINKAGE OF WOOD.

The worker in wood has the problem of shrinkage before him always. It may be a serious and perplexing problem, or it may not amount to much. It depends upon the kind of wood and how it is being handled.

When green wood is subjected to dry heat it parts with moisture and contracts in volume, but no precise ratio exists between the quantity of water expelled and the extent of the shrinkage. Actual tests are required to show the contraction in bulk of a certain kind of wood during the drying process; and in order that one wood may be compared to another, it is necessary that all be subjected to the same treatment. That usually consists in reducing the specimen from a green to an oven-dry state. Oven-dry wood is drier than it is ever made in a kiln.

Wood shrinks more rapidly towards the end of the seasoning process than near the beginning. It does not shrink equally in all directions; but most tangentially, next radially, and least lengthwise. Tangential shrinkage lessens the circumference of a round log; radial shrinkage lessens its diameter; and lengthwise shrinkage shortens it. Shrinkage in all three directions lessens the log's volume.

It is not possible to name a precise rate or amount of shrinkage for wood. Each kind has a rate or amount of its own; and the behaviour of one is no guide to the behaviour of others, because one may contract two or three times as much as another. As nearly as averages can make a rule, it may be worded thus:—Wood shrinks lengthwise one-fifth of 1 per cent.; radially 5 per cent.; and tangentially 8 per cent. A round log 42 feet long and 20 inches in diameter when green, would, if the above rule is applied, have the following dimensions when oven-dry:—Length 41 feet 11 inches; diameter, 19 inches; circumference, 56 inches (a reduction of about 4 inches in circumference).

It should be clearly borne in mind that these figures are intended to apply in a general way only, are based on average and may not hold true if applied to a particular wood. In many individual cases they certainly do not hold true.—*Hardwood Record*, Chicago.—[*Reprinted in Timber Trade Journal.*]

A NEW WOOD, THE LIGHTEST KNOWN.

A new wood, apparently little known and called balsa wood, is exceedingly light and promises to have an extended field of usefulness in connection with cold storage structures when heat insulation is important. It is a tropical wood growing principally in the states of South and Central America.

The wood is remarkable, first, as to its lightness; second, as to its microscopical structure; third, for its absence of woody fibre; fourth, for its elasticity; and fifth, for its heat-insulating qualities. So far as the investigation has disclosed, it is the lightest commercially useful wood known. It has also considerable structural strength, which makes it suitable for many uses. In general appearance balsa wood resembles basswood. Until recently, Missouri cork wood, weighing 18·1 pounds per cubic foot, was believed to be the lightest, but recent investigations indicate that balsa wood is much lighter, having a net weight of 7·3 pounds per cubic foot. The ordinary commercial balsa wood is seldom perfectly dry, and, because of the moisture content, its weight has been found to be between eight and thirteen pounds per cubic foot.

The extreme lightness of this wood suggests its application as a buoyancy material in life-preservers and life-boats. When, however, it was attempted to apply the wood practically, it was found to be of little value, because it absorbed water in great quantities and also because it soon rotted and also warped and checked when worked. After testing nearly every method that had been suggested, Colonel Marr's method of treating woods which had been recently patented was finally successful. In this method the wood is treated in a bath, of which the principal ingredient is paraffin, by a process which coats the interior cells without clogging up the porous system. The paraffin remains as a coating or varnish over the interior cell walls, preventing the absorption of moisture and the ill-effects as to change of volume and decay which would otherwise take place; it also prevents the bad effects of dry rot which follow the application of any surface

treatment for preserving wood of the same type. The Marr process tends to drive out all water and make the wood water-proof; it also improves its quality of being readily worked with tools, without material increase in weight. The treated balsa wood has been used extensively in the manufacture of life-preservers, fenders for life-boats and for structures requiring insulation from heat, as in the refrigerating compartment of vessels and ice-boxes. —[*Scientific American*.]

PAPER-PULP FROM AUSTRALIAN LALANG GRASS.

A well-known agricultural and technical chemist in Queensland has, says the *Indian Trade Journal*, conducted very successful experiments in manufacturing paper-pulp out of *lalang* grass, or, as it is more commonly known, blady grass, on account of its very large blades which are four or five feet long. It resembles very closely the "esparto" of Spain and North Africa, and when dried before making it into pulp it yields as high as 60 per cent. first-class paper-making pulp. The expert states that esparto is the best pulp known, and the blady grass product is within 10 per cent. of the same value. There are millions of tons of this grass growing in Queensland. Three crops in a year can be cut from it, and this plant is said to be otherwise a curse to the country. He is also experimenting with other plants with good results, namely, Chinese "bar" (*Urena*) and the Queensland hemp (*Sida retusa*). They produce 30 per cent. of first class paper-pulp. Lantana, which is also regarded as a great pest, makes an excellent wrapping paper. Screw pine, or Pandanus, which also grows prolifically, is also the subject of experiments—[*Scientific American.*]

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SUGGESTIONS TO INTRODUCE SPECIAL WORKING PLANS FOR THE EXPLOITATION OF *BASSIA LATIFOLIA*, ROXB., AND *BASSIA LONGIFOLIA* IN INDIA, AND TO RESTRICT THE MANUFACTURE OF THEIR RAW PRODUCTS WITHIN THE EMPIRE.

BY G. M. RYAN, I.F.S. (RETIRED).

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C/O MESSRS. H. S. KING & CO.,
9, PALL MALL,
LONDON, S.W.

FROM

G. M. RYAN, ESQ.,
IMPERIAL FOREST SERVICE (RTD.),

TO

THE SECRETARY OF STATE FOR INDIA.

London, 29th November 1917.

SIR,

I have the honour to submit, for the favour of perusal, the accompanying copy of the Journal of the Royal Society of Arts of the 25th May 1917, containing (*a*) a paper read at a Meeting of the Society on the 19th April at which I was invited to be present, on the Recent Industrial and Economic Development of Indian Forest Products, by Mr. R. S. Pearson, Forest Economist, at the Forest Research Institute, Dehra Dun, and (*b*) subsequent proceedings of the Society. (Appendix I.)

In submitting these printed papers, I take the opportunity of making the following remarks about *Bassia latifolia*, Roxb., and *Bassia longifolia*, and the liberty of offering some suggestions as to the necessity which seems to exist of drawing up special Working Plans for their preservation and extension in India, and of attempting to restrict the manufacture of their raw products within the Empire which, I trust, may meet with favourable consideration.

1. PRELIMINARY REMARKS.

Bassia latifolia, commonly known as Mhoura in Western India and Mahua in other parts, has attracted my notice for a considerable period during my service as being a tree of great commercial importance and unique interest in India, and I thought that perhaps, by this time, something might have been attempted in the way of securing its future regeneration in Bombay at least, if not in other parts of India—seeing that its economic products, especially seeds, have been such an important article of export from that country for some years past.

After hearing Mr. Pearson's interesting paper read, however, I was somewhat disappointed to find that nothing apparently has been done yet in this direction.

In the discussion which followed on the reading of the paper in which I was invited to take part, what I actually said was somewhat as follows :—

"It appears from Mr. Pearson's excellent paper that a great deal is being attempted by the Forest Department towards the economic development of the forests in India, by endeavouring to find new products and by establishing new industries there, but that no mention was made in it of any attempts to organize and develop the collection of those forest products which have already a commercial footing and some of which are largely exported from India, *viz.*, Mhoura, Myrabolans and Bamboos."

From want of space, my detailed observations on these points were not reproduced in the proceedings of the Royal Society of Arts. It will be seen, however, from a perusal of so much as has been published, that reference was made to the absence of regeneration of Mhoura and that probable reasons were assigned for such want; and it is proposed now to make this the basis of my present representations. Without systematic arrangements being made for the regeneration of a species in a forest under exploitation, it is obvious that the future of that species must be seriously jeopardized. This fact is so patent that it would appear superfluous to mention it. The principle is recognized and given practical effect to in organizing the output of major forest products such as timber and firewood and some minor products such as rubber and lac—so why not in the case of Mhoura?

The reason may be, as alleged in my remarks at the Society of Arts meeting, namely, that the presence of the Mhoura tree in forest is objected to because of its being a fertile cause of forest fires and also a source of intoxicating liquor, which objections I will now briefly enter into.

2. Danger of Forest Fires from Mhoura Trees.

Adequately to understand how it comes about that Mhoura trees are a source of forest fires, it is necessary to explain

first this relation between cause and effect. In the month of March, which is the beginning of the hot season in the Mhoura region, the tree comes into flower. After pollination has been effected the corollas get disengaged from the calyx, and drop one by one on the ground during the night and cool hours of the morning and evening. In the forests, grass and dry leaves are to be found in quantity beneath the Mhoura trees—and the corollas falling in amongst the rubbish are difficult to gather. In order, therefore, to facilitate their collection the ground underneath the trees is usually cleared of all grass, etc., by burning previous to the fall of the corollas. It can easily be imagined, under the circumstances, that in wind-swept forests, where the grass is as dry as tinder and abundant, how a fire once started beneath a tree must spread in a forest, unless special precautions are taken. Great damage, no doubt, results at times to a forest from negligence of this kind. Measures, however, are adopted to check such carelessness and to control fires in a forest if they occur. In addition to a permanent staff of forest guards, special gangs of men known as fire-guards are annually employed to patrol the forests in the dangerous season and to suppress them. Their duty is not only to patrol and extinguish fires but to demarcate the forests into restricted areas by cleared rides 50 to 100 feet wide. Special legislation is in force, also requiring persons to clear minor rides round each Mhoura tree or group of such trees, to prevent the spread of a fire into the forest if one is started by anyone under the tree. Measures to provide for almost every conceivable contingency are, in fact, in force to securely protect the forests from burning. Fires occur nevertheless; but it is well known that such accidental fires are not peculiar to the Mhoura tracts: they occur all over India in State and private forests where rights of user exist.

One cannot help but sympathize with some Forest Officers, however, who being anxious about the satisfactory regeneration of their forests advocate the removal of Mhoura trees from them in order to reduce the risk of fires from the above cause.

But, surely, this negative attitude is not the proper one to adopt in connection with a tree which, as I propose to show in this

report, is probably more valuable to the State, both financially and in various other respects, than any in India.

The proper course, under the circumstances, for the Forest Department is to grapple with the evil, and try and overcome it by efficient administrative methods which is feasible, I submit, with the means the State provides for the purpose.

3. Corollas of Mhoura—a source of Intoxicating Liquor.

It is unnecessary for me to enter at any length into this subject, for the utility of the dried corollas of the Mhoura flower for the purpose of manufacturing country liquor is well known. In the Bombay Presidency this manufacture is State-controlled, and the right to purchase the corollas in the forests and to manufacture the liquor for public sale yields a large annual revenue to the State. In consequence, however, of the evil resulting from Mhoura liquor drinking—increase of crime, for instance in Guzerat, in a favourable flowering season is attributed to the excessive drinking of the Mhoura spirit—many Revenue Officers dislike the Mhoura tree and object to any extension of its cultivation.

They are, no doubt, perfectly justified in their attitude in this respect, but it is a question for decision whether the evils resulting from the abuse of Mhoura liquor drinking outweigh, in importance, the great utility of the corollas and seeds as articles of food to the people.

I propose briefly to touch on these points now, and to explain that recently a new use has been found for the corollas which so enhances their economic value as to outweigh any objections arising from their being a source of intoxicating liquor.

One might as well object, it appears to me under all the circumstances of the case, to the cultivation of the potato because it is a source of alcohol, as object to Mhoura. However, this is a question for the consideration and decision of Government, and I respectfully hope that it will be settled once and for all.

4. Economic uses of the Corollas.

About 33 years ago, it was estimated in the Central Provinces (vide *Dictionary of Economic Products*, Vol. I, pp. 410-411) that

over one million people used the corollas of the Mhoura as a regular article of food, each person consuming about 80 lbs. per annum, an amount that would set free about 120 lbs. of grain or 30 per cent. of the food necessities of the people. This, at the lowest estimate, comes to one-quarter of a million pound sterling which the value of the tree represents in the Central Provinces alone.

In the Bombay Presidency, the dried corollas of the Mhoura have a similar high economic use. They always have been held in high estimation as an article of diet amongst the Bhils and other forest tribes, and continue to be used for domestic consumption on a large scale by them and others. Almost every district officer, in fact, knows this, and it is well understood too what a stand-by these corollas have been in seasons of scarcity or famine. In parts of Guzerat and the Satpura Hills in Khandesh, the existence of a good crop of Mhoura flowers, as they are popularly called, has often staved off the necessity of Government relief measures in a famine year. But it is perhaps unnecessary to labour the point of the value of the corollas as an article of diet—the fact is too well known.

5. New use of Corollas.

Since the outbreak of war, however, a comparatively recent chemical analysis of the corollas has proved them to be a source of acetone, which is the chief ingredient in the manufacture of cordite. *This discovery, it is* thought, lends not only to remove at once any doubt which may have previously existed as to the desirability of encouraging the growth of *Bassia latifolia* in forests and waste lands, but makes it more incumbent on the part of the State to foster and extend its production.

It is well known that acetone can be obtained by the destructive distillation of wood, but 100 tons of wood yield, at best, only one ton of acetone.

Fresh Mhoura corollas, on the other hand, it is alleged, will produce about one-tenth their weight of acetone, or nearly ten times as much as is obtainable from wood ; and they can be had in

comparative abundance. The great value of the corollas, therefore, can be judged at a glance, if this information is correct, independently of their other economic qualities.

With acetone at £180 a ton, well might the extension and cultivation of the Mhoura tree in forests and waste lands be taken in hand for almost that purpose alone.

In normal times, perhaps not a very great quantity of acetone —say about 500 tons annually may be required for military needs in India: but the British Empire's requirements in this direction must not be lost sight of. It will be possible, it is understood, to export the surplus stocks of dried corollas from India all over the Empire, with considerable economy and profit, for the purpose of the manufacture of acetone. However, apart from acetone, there are other avenues of possible use for the corollas such as sugar and motor spirit as Mr. Wakefield has explained in his note.

Some years ago, a chemical analysis of the dried corollas demonstrated the existence in them of 49·8 per cent. invert and 13 per cent. cane sugar (*vide* Annual Report of the Board of Scientific Advice for 1909-10, p. 29). At a time when the quantity of sugar available within the Empire is so limited, the successful preparation of it from the corollas of *Bassia latifolia*, if possible, would be a great advantage. This, it is believed, is already engaging the attention of the Government of India.

6. Mhoura Seeds—a valuable Commercial Product.

Apart from the economic uses of the corollas, as above explained, the cotyledons too, or seeds as they are popularly termed, are of considerable commercial value, mainly for export to Europe. This matter, however, need not be entered into at any length here for the commercial importance of the seeds was fully ventilated in a paper I wrote on the subject in 1904, which has been favourably commented on by Sir George Watt in his work "Commercial Products of India" (p. 120), and since 1907 the Bombay Government have been exploiting the seeds from some of their forests and waste lands at considerable profit (*vide* correspondence

commencing with my No. 267 of the 6th October 1903 when I was in charge of the Central Thana Forest Division printed as an accompaniment to Government Resolution No. 2194 of the 19th March 1904 and ending with Government Resolution No. 1077 of the 3rd September 1906 and subsequent Resolutions). Suffice it to say here that the exports of Mhoura seeds from India from 1907 up to the outbreak of the war in 1914 were as follows:—

			Calcutta.	Bombay.
			Tons.	Tons.
1907	...	...	1,900	29,453
1908	...	...	259	25,988
1909	...	...	4,545	31,275
1910	...	...	4,295	18,952
1911	...	...	4,077	35,818
1912	...	...	269	13,861
1913	...	...	567	31,034
1914	...	...	357	7,771
			16,269	194,152
				16,269
			8)	210,421
			Average	26,302

The above figures have been supplied through the courtesy of Messrs. Ralli Bros., London, who are the largest exporters of Mhoura seeds in India. They estimate the value of the Mhoura exports at £12 per ton, according to which rate the annual value of the total exports for the past eight years would be £315,630.

From the statement attached (Appendix II) it will be understood what the probable sources of these exports are, as well as their estimated value to each Presidency or Province or Native States in British India. The estimates of Native States are given in lump. In the Bombay Presidency, it will be seen that if all the State areas where Mhoura is now found were exploited officially, a net income of about Rs. 1,20,000 might be expected annually therefrom. Similarly, an income of about Rs. 10,000 annually is

estimated from Madras. It is difficult to estimate the returns from other Provinces because of the absence of details affecting Mhoura in all their Annual Reports. I have entered, to the best of my knowledge, a total sum from such places which would be realizable, if all the areas in them were exploited under State control, *viz.*, Rs. 1,05,000. Speaking generally, Mhoura is found in comparative abundance in the Central Provinces and Chota Nagpur but less so in the United Provinces and Bihar and Orissa.

The total revenue from Native States is estimated at Rs. 1,80,000. The largest sources of supply would probably be from Hyderabad (Nizam's Dominions) and Indore (Holkar's Dominions). In Baroda, efforts are being made, I understand from Mr. R. H. Madan, the energetic Conservator of Forests, to extend the area under Mhoura in forests, especially in the Kathiawar region and elsewhere.

7. SUGGESTION TO RESTRICT THE MANUFACTURE OF THE RAW PRODUCTS OF MHOURA WITHIN THE EMPIRE.

Since the outbreak of the war, the exports of seeds from India have, owing to the want, it is understood, of transport to Europe, diminished considerably. The seeds were mainly utilized on the Continent, chiefly in Germany and Belgium, before the war for the manufacture of margarine and soap, etc. Rapeseed and linseed have now taken its place, it is understood, especially for margarine manufacture because of their smaller bulk and consequent cheaper freight, and are shipped to Holland. The rapeseed and linseed are admitted into Holland now apparently under license, and a proportionate quantity of margarine is exported to England. It is hoped that, after the war, this expensive and unsatisfactory state of things will not be allowed to continue, but that the production and handling of this, as well as other products of the tree, will be so organized as to restrict their manufacture within the Empire. There seems no reason now why India should not undertake this task or failing that England, and I have already broached this subject to the chief partner, in London, of one of the leading Indian firms who is considering the proposal favourably.

8. NECESSITY OF ORGANIZED MEASURES FOR THE REGENERATION, ETC., OF MHOURA.

I can scarcely believe that the State wishes this valuable commercial article and the other important products of the tree to become gradually extinct as they assuredly will, unless special organized measures for the natural and artificial regeneration of the tree and control of seed exploitation are adopted.

It must be remembered that many commercial firms are engaged in Bombay and Calcutta, in England and on the Continent of Europe, in trading in Mhoura seeds, and that the demand for the seeds leads to the regular employment of a large number of people in India, at a slack season of the year (so far as the demand for labour is concerned), who earn a good living by collecting them for the mercantile community. Is it not the duty, under the circumstances, of the State, which owns a large proportion of the trees from which these seeds are gathered, to make systematic attempts to keep the trade in being and urge others also to do the same? At present nothing apparently like this is being done, or even proposed, and unless the Mhoura areas all over India are brought under scientific organized plans the trade in Mhoura seeds and the fate of the other highly valuable economic products of the tree are doomed.

It is necessary to emphasize this and to suggest that not only should some organized attempts be made promptly but that the measures should include increased production of the tree wherever it is found.

In some localities, such as East Khandesh, Mhoura has already commenced to disappear, and in the Panch Mahals where thousands of trees died, as stated by Mr. Pearson during the prolonged drought of 1899—01 (vide *Indian Forester*, p. 124, Vol. XXX, 1904), the number of trees now living is considerably less than in former times.

In the Konkan, some natural regeneration of Mhoura is observable, it is true, due chiefly to the action of flying-foxes and crows which eat the fruit and distribute the seeds, but such regeneration is negligible for all practical purposes.

But it can be understood that natural regeneration, generally speaking, must be practically *nil* from the fact of no seeds being left on the ground, owing to such large collections, mainly for export to Europe.

Nature obviously intended that a certain proportion, at any rate, of these seeds should be left on the ground to promote reproduction of the trees. It must not be forgotten also that the annual removal of the corollas, by a clean sweep from the ground as it were, by the people for their own and trade purposes must, to a very great extent, impoverish the soil, and thereby add to the difficulties of natural regeneration of Mhoura, as well as probably curtail the life of the tree. It is more than probable that the sugar in the corollas, if left on the ground, would ferment, and that the products of fermentation would be absorbed by the soil and become available for the roots of the tree. Wild animals too, such as bears, hyænas, jackals and deer especially being attracted by the abundance of food would collect under or near the trees in the Mhoura region and by their constant droppings assist in fertilizing the soil.

In the Dangs (Surat District) monkeys are known to collect on the trees to eat the fruit and seeds of the Mhoura in such large numbers as to considerably reduce the supply of seeds available for export.

Is the present unsatisfactory state of things with regard to the regeneration of Mhoura to be allowed to continue ? In the words of an able Forest Officer of the Central Provinces, Mr. Fernandez, when writing many years ago about the future of Mhoura, " Is this goodly endowment of bountiful nature, this inheritance, to be wrecked or impaired ? "

It is the duty of the Forest Department, of all others, I think, to prevent this : to see that the present generation of inhabitants does not endanger the wants of future generations by attacking the capital when it is only entitled to the annual yield. This principle is recognized and followed, as already remarked in regard to the exploitation of timber, firewood and rubber and probably lac in some places, but not in all as far as I am aware :

at any rate, not in the Bombay Presidency ; but, in regard to Mhoura, it seems to be entirely neglected. It is especially necessary, however, in its case. As a purely commercial undertaking, it would pay to devote time and energy to the growth of Mhoura because the annual financial yield from the disposal of its minor products alone would, it is thought, exceed the revenue derivable from timber and firewood if grown on the same area.

It might be objected that this is a fallacious argument because a timber and fuel crop could be grown more closely on the land and that, therefore, the annual financial yield of such crop would be in excess of that realized from the minor products of, say, 15 or 20 Mhoura trees which might instead be the number grown on the same area; but a close investigation into the subject will, it is thought, dispel this contention.

Under an efficient organized scheme 15 to 20 large Mhoura trees could be grown per acre—with junglewood species intervening—whereas, omitting Mhoura from the area altogether, a crop mainly of junglewood species, yielding only material fit for fuel, would be obtainable. In the Panch Mahals and parts of Khandesh, teak is an associate of the Mhoura, it is true, but it is mainly of the size of poles and is usually dominated by the former. The growth of the two in the same area, therefore, would not be irreconcilable.

9. MHOURA AS A VALUABLE TREE FOR AFFORESTATION PURPOSES IN THE DRY ZONE.

It would be lamentable, from an œcological point of view, to allow Mhoura to disappear from, say, the Deccan and Central India and parts of Rajputana-Guzerat, because it is specially adapted by nature with qualities to thrive in such localities which are subjected to long periods of drought, and scanty and capricious rainfall. In a word, it might be characterized as a xerophytic type of vegetation, that is a tree supplied by nature with special adaptations for obstructing desiccation. It is, by habit, a deep-rooted species but can adapt itself to shallow soils, as in the Satpura Hills, by the formation of buttressed roots :

possesses a thick bark, and below the bark abundant latex which is a provision of nature for mitigating the effects of radiant heat. The leaves are coriaceous and the wood dense and hard. There are no other species in the same zone, except Salai *(Boswellia serrata)* and some Apocynaceous and Asclepiadaceous shrubs that possess such xerophytic characters. Apart, therefore, from its economic and commercial aspects it is of supreme importance to encourage its growth for climatological reasons, especially in the hilly tracts of the dry zone. In the areas in Guzerat where trees in thousands are said by Mr. Pearson to have died from severe drought, Mhoura probably was an introduced or cultivated tree; but in Khandesh where it is indigenous long continued drought has not had the same effect.

10. SUGGESTION AS TO THE BEST FORM OF WORKING PLAN FOR MHOURA.

It is not possible to suggest a uniform Working Plan for Mhoura as localities differ so much all over India and conditions are so variable but, speaking generally, a plan based on the number of trees to be exploited annually would probably meet the requirements of the case better than any other founded on volume or area.

If my own experience is of any assistance in the drawing up of such a plan, I am happy to give it for what it is worth, trusting it may be of some service because the problem of dealing with *Bassia latifolia* is complicated by reasons of trees having to be dealt with not only in forests but waste lands, and it may, therefore, at first sight, seem unworkable. Moreover, any plan based on the enumeration of trees might be considered too laborious and expensive a task for the Working Plans staff to undertake.

When holding charge of the North and Central Thana Forest Divisions of the Northern Circle, Bombay, in 1904-05, I was confronted by a very awkward problem owing to the effects of a severe cyclonic storm in those Divisions. Thousands of sound healthy teak and other trees in forest and teak in waste and

occupancy lands, were blown down; but the bulk of the damage resulted to the teak and over one million of such trees came to grief. A sanctioned Working Plan already existed for the forest areas where this storm occurred. Were the prescriptions of this plan in these areas to be carried out in spite of the disaster, and the uprooted trees in the different blocks dealt with accordingly, or was the plan to be entirely suspended and a new scheme drawn up for the damaged trees only? The problem was solved by, first, a suspension of the existing Working Plan with the consent of Government.

An entirely new rough plan was drawn up, instead, with the approval and co-operation of the Collector and Government, under which several working circles were formed and the unit of area of exploitation was taken as the *Forest Round*, which of course included tree-covered areas in forest and non-forest villages. The fallen teak trees only in the villages of this Round were enumerated by the local guards and revenue subordinates—and when the lists were prepared, a fixed number of the trees was sold by tender to the highest bidder. In this way, it took about five or six years to enumerate and dispose of all the uprooted teak trees, but the counting was gradually and successfully carried out; and my contention is that, in the case of a valuable tree like the Mhoura, a similar enumeration, with the co-operation of the Collectors in each Division, according to two age-classes, *i.e.*, non-bearing and bearing trees, might be conducted gradually, and without the expense of any special enumerating staff.

Such enumeration would probably be extended over a couple of seasons only. The above is merely an outline—intended to help the officers responsible for devising a practical scheme for exploiting the tree. A full-grown Mhoura is, in my estimation, more intrinsically valuable to the State than any other forest tree in India, reckoning its productive capacity to commence at 20 to 25 years, and to extend to about 200 years at which period it could be felled and utilized for fuel or timber, its timber being of excellent quality; and it is worth while, therefore, having an enumeration made of the trees such as is suggested.

It would be easy to support the statement as regards its comparative financial value by simple arithmetical calculations, framed on the excellent financial results realized from the experimental departmental collection and sale of the seeds alone (*vide* Government Resolution No. 2521 of the 9th March 1908 and subsequent Resolutions in 1910), which showed a net profit of Rs. 2-3-11 per cwt.; and by quoting the enormous annual revenue derived from the sale of the corollas to liquor contractors, which in some years in West Khandesh has exceeded the entire land revenue of the Taluka. Such a calculation, however, would be misleading, as several economic factors would have to be taken into account in comparing results with timber areas which would vitiate the value of the figures.

But there seems little doubt that, in the region where the Mhoura exists, it is *par excellence* the tree whose growth should be encouraged or developed from every stand-point, economic, commercial, financial and climatological, and more especially now when its utility as a source of acetone and its potentialities as a producer of sugar are considered.

11. Mhoura as an Indian Planter's Tree.

And this leads me up to the question of considering whether it would not be advantageous for Indian gentlemen to cultivate the tree in the same way as Englishmen and others cultivate rubber, etc., in Ceylon and other places?

There are extensive tracts of open land outside forest where *Bassia latifolia* in the north, and probably both *Bassia latifolia* and *Bassia longifolia* in the south, of the Presidency could be grown with profit, provided facilities are offered for such cultivation by the State to Parsee, Mahomedan and Hindu gentlemen. The grazing requirements in the areas so treated would not be interfered with. If a practical demonstration of the probable success of such a measure is sought, one has but to go to the Khaira District in Guzerat, where no State forests exist but where thousands of Mhoura trees can be seen growing

in waste areas. The oil from the seeds here is locally manufactured into soap.

It requires no stretch of imagination to realize that, with the advance of education and increased enterprise on the part of the people, if Mhoura is grown abundantly in other parts and annual supplies *permanently* assured, higher class margarine and soap factories would probably spring up in or near the Mhoura tracts to take the place of those which now exist thousands of miles away in foreign countries in Europe. The value of the unproductive lands in Broach and Ahmedabad could, it is thought, be also considerably enhanced under a well thought-out scheme of planting.

Parsee gentlemen are particularly enterprising in the farming and fruit-growing lines, and educated youths amongst them might find suitable occupation in growing Mhoura or other fruit trees on their lands. Many of the liquor contractors in the Presidency, notably Mr. Cowasjee Dadabhoy Dubash of Bombay, are Parsee gentlemen, and in North Thana there are some well-educated farmers such as Mr. Bhilladwalla. This is the gentleman who, in 1899, gallantly came forward and supplied a large quantity of fodder from the Thana District for the famine-stricken cattle in Ahmedabad in Guzerat when Government measures for their relief had failed. I merely recall this incident as a compliment to Mr. Bhilladwalla and as indicative of his enterprising spirit: and I expect there are others like him. At any rate, there must be Parsee families with sons who might very well be induced to take up the idea of being Planters, just as Englishmen have taken up the growing of Tea and Rubber, etc., elsewhere. The late Mr. Malabari, the Indian Reformer and writer, once asked me what occupation outside the towns could be found for Parsee youths and, at the time, this idea of planting Mhoura in particular never occurred to me.

I submit the suggestion for the favourable consideration of Government as an experimental measure in selected localities, if it is not considered politic to include the trees in waste lands under efficient organized treatment.

12. THE SEEDS OF *Bassia longifolia* PROBABLY BEING EXPORTED FROM INDIA AS "MHOURA SEEDS" BY MERCHANTS.

In 1908-09 a sample of this seed of *Bassia longifolia* from the Southern Circle, Bombay, was submitted by me to Messrs. Ralli Bros. in London for opinion and their report on it was so favourable that I forwarded it to the Secretary of Government, Revenue Department, Bombay, for information and with the suggestion that an experimental shipment of two tons of *Bassia longifolia* might be made to London from the Southern Circle; but my proposal did not meet with acceptance.

The Conservator of Forests, Southern Circle, Bombay, informed Government that the tree, though found throughout the moister forests of Kanara, was nowhere abundant, that the seed was not found in paying quantities and that he could not collect two tons with any facility. It was suggested to me by the Under-Secretary to Government, Revenue Department, Bombay, in his demi-official letter of the 16th February 1909 that 'the facts I had quoted about the value of *Bassia longifolia* seeds would be of more use to the Madras Government than Bombay and that it might be worth while giving it to them.' As I had already written to the *Indian Forester* on the subject (*vide* my article in that Magazine, Vol. XXX, p. 465), the matter then dropped.

In reconsidering the question, however, recently, it has occurred to me to enquire whether the Conservator of that period might not have been mistaken about the true position of *Bassia longifolia* seeds as then existing? My belief is that some seeds of this tree were probably being collected and exported by dealers at the time of his report above quoted from the forests and waste areas of the Southern Circle or Madras Presidency and sent to Bombay. No mention, it is true, is made in the *Dictionary of Economic Products* or other work on Indian Economic Products of the seeds of *Bassia longifolia* being an article of export to Europe from India; but I am induced to believe that it has been an article of such export for some years.

Both *Bassia latifolia* and *Bassia longifolia* are found in Southern India, the former being scattered and not very abundant,

while the latter is more common and bulks very largely in the Nallamalai Hills of the Kurnool District in the Northern Circle, Madras. From information obtained from the Bombay Chamber of Commerce in 1904, it was ascertained that Mhoura seeds were being conveyed to Bombay for export to Europe, *via* Harlapur on the Southern Mahratta Railway. New *Bassia latifolia* and *Bassia longifolia* seeds are morphologically so similar as to be indistinguishable to the ordinary eye when mixed. It appears to me, therefore, as likely that the two were probably being collected from some source in Southern India at the time of my enquiries and booked to Bombay by rail as " Mhoura seeds."

Moreover, no mention in Annual Reports is made of any State exploitation of *Bassia longifolia* or *Bassia latifolia* seeds from Madras or the Southern Circle, Bombay, and I may, therefore, be wrong in my surmise; but the matter is worth investigation. There must have been a leakage of " Mhoura seeds " somewhere, at any rate from Southern India in 1903-04, and probably this leakage continued up to the outbreak of the war in 1914. It may recommence after the war is over, when the export trade in Mhoura seeds is certain to be re-established.

An investigation into the subject is suggested, because a similar leakage was noticed in connection with *Bassia latifolia* seeds from the forests and waste lands of the Northern and Central Circles, Bombay, in 1903-04 when their exploitation was first recommended; but the Conservator of Forests, Northern Circle, at the time, as will be seen from his letter No. 563, dated 31st May 1904, to the Chief Secretary to Government, Bombay (printed as an accompaniment to Government Resolution No. 2918, dated 7th April 1905), reported against my proposal, because he said " much revenue could not be obtained in his Circle from it as the trees were not sufficiently plentiful in the forests and their produce was already largely taken for direct consumption or for barter by the people who had hitherto been allowed the privilege " ; and the Conservator of Forests, Central Circle, reported very much in the same way about conditions in his Circle. I regret my inability to quote the number and date of the latter's letter, not having kept

a record of it—but this is so according to my recollection. These reports, it must be mentioned, were addressed to Government at a time when merchants were collecting and forwarding the seeds from the Thana, Khandesh and Nasik Districts to Bombay for export to Europe.

I had written a short article after careful investigation into the Mhoura seed question in the *Indian Forester* for December 1903, pointing out the increased demand for the seeds in the European markets, and had estimated the revenue from them available for export to Europe from an insignificant area in the Thana District, Northern Circle (after the domestic and other wants of the local inhabitants had been provided for) at about Rs. 1,635.

The information given in my article seems to have been overlooked. The experimental collection as recommended by me was, however, carried out under the orders of Government in Thana with successful results and it may be interesting to give the actual most recent results of the receipts from this source; for they show that my original estimate of revenue, viz., Rs. 1,635 was prepared with caution.

				Rs.
1910-11	...	...	...	3,049
1911-12	...	...	...	1,955
1912-13	...	...	...	2,468
1913-14	...	...	...	2,229
				4) 9,701
		Rs.	...	2,425

The Conservator had traversed the district and, after personal observation and enquiries (*vide* para. in his letter above quoted), had come to the conclusion that, owing to the paucity of the trees, it was not worth while exploiting them for their seeds, and yet from the small number in the district an annual net revenue of Rs. 2,425 has been obtained. This is, if need be, very emphatic evidence of the high value of each tree, apart from the value attaching to the corollas which is even higher. But, in the Central Circle, the information that existed of large exports of seeds which were taking

place from there has been more than confirmed by subsequent results. In consequence of the adverse report of the Conservator, in the first instance, this exploitation was not taken in hand there. Three years afterwards (in 1906), however, I was appointed to hold charge of the Central Circle, and I induced Government to undertake an experimental collection of the seeds in the Khandesh District of that Circle.

The experiment proved so successful that Government ordered the exploitation to be carried out in Nasik also with the results that it has been continued, and for the four years ending 1914 when the war broke out the receipts from Mhoura seeds in the Central Circle have averaged about Rs. 50,000.

The average *net* returns annually are probably about a quarter of a lakh of rupees, a sum not to be despised when it is understood that the Mhoura trees exploited are comparatively few in number, and when the total forest revenue in Khandesh, at the time of the suggested exploitation, barely exceeded the expenditure, and when also in the Panch Mahals and Surat where Mhoura is abundant deficits were apparent. (*Vide* Note on Mhoura printed as an accompaniment to Government Resolution No. 2918 of the 7th April 1905.)

13. OBJECTIONS TO EXPLOIT MHOURA SEEDS IN CERTAIN PARTS OF THE BOMBAY PRESIDENCY CONSIDERED.

Under the circumstances of the above record it is left to Government for decision whether any enquiry and any action shall be taken with regard to the exploitation of *Bassia latifolia* and *Bassia longifolia* seeds in the Southern Circle or elsewhere, and whether any organized schemes, at the same time, shall be introduced for preserving and developing this new source of revenue both where exploitation is carried on under the authority of Government or not.

As shown in the Statement appended, Government exploitation of Mhoura is not carried on in the Panch Mahals and Khaira, of the Northern Circle, where the trees are comparatively abundant both in forests and waste lands. This is because the local Revenue Officers in the Panch Mahals when consulted on the subject

originally vetoed the proposal mainly because, it was alleged, the rights and privileges of the people would be interfered with thereby.

I would invite attention to identically the same objections which were raised against the exploitation of the trees in the Northern and Central Circles originally and which have proved fallacious. This has been explicitly declared to be the case by the Bombay Government in para. 3 of their Resolution No. 3315, dated 28th March 1907, where in issuing orders on the experimental collection of seeds in the Khandesh District of the Central Circle they remarked as follows :—" Government note with satisfaction that so far from the withdrawal of a privilege granted to the Bhils by the North Tapti Code having operated to their disadvantage it has turned to their profit."

The farming out of the right to collect the produce of trees does not interfere with the rights and privileges of the people to that produce, as experience has proved in other districts and as abundantly demonstrated in other parts of India also where Mhoura is also exploited with considerable profit. In what respect, therefore, Guzerat differs from other parts of India, it would be interesting to know ? And in what respect also is the legal position of Mhoura there different to that of *Terminalia Chebula* ; for instance, in the Southern Circle, as elsewhere, which yields the Myrabolan of commerce and which is exploited by Government ? I think these are points requiring investigation because, judging by the reports of the Conservators of Forests, Northern and Central Circles, already alluded to and the report of the Collector of the Panch Mahals No. 2349 of the 30th May 1904 (printed as an accompaniment to Government Resolution No. 2918, dated 7th April 1905), a good deal of misunderstanding seemed to exist about the alleged restrictions which farming out the produce of the trees would impose on the people.

Misunderstanding of this sort results sometimes in serious loss of revenue, as evidence the Central Circle, Bombay, which remained about four years, in spite of admonitions, without State exploitation of Mhoura seeds, involving a net estimated loss of about one lakh of rupees. But exploitation of Mhoura is

recommended not only for the sake of realizing revenue from it, but also to enable organized plans for its future to be framed where the demands of user are heavy, as is the case with Mhoura in the Panch Mahals, Khaira, and elsewhere and it is imperative to meet this demand by properly organized measures—in the interests of the State and people and not to let things drift, if I may be pardoned for so saying, as is being done at present by the Forest Department. The export trade, under present conditions, must, it is believed, eventually fall off and will probably cease altogether in time, unless some such measures are adopted to arrest the evil because it is abundantly proved that in matters of this kind the people do not act for themselves. They live without a thought beyond present necessity. These remarks are not applicable of course to India only, but to exploiters of commercial products all the world over who invariably try to kill the goose with the golden eggs.

14. Reference to the Report of the Royal Commission on Natural Resources, Trade and Legislation of the Overseas Dominions.

I take the opportunity of inviting attention, in this connection, to the report of the Royal Commission on Natural Resources and Trade and Legislation of the Overseas Dominions, wherein the better handling and disposal of the resources of the various parts of the Empire are recommended, and it seems to me that the raw products of the *Bassia latifolia* and *Bassia longifolia*, wherever they are found as export articles, are such as to come under this category.

It is certain that unless some organized plans are drawn up to secure the future of *Bassia latifolia*, and probably *Bassia longifolia*, the supplies of their raw products, especially seeds which are now very variable in quantity each year, will become more so in time and probably cease altogether at any rate for all practical or commercial purposes. With such a prospect in view, it can hardly be expected that European and Indian gentlemen will be induced to sink much, if any, capital in endeavours to establish up-to-date factories in India or elsewhere for the manufacture of the raw products on the spot.

15. Conclusion.

Apologies are offered for having written at such length on the subject and for the liberty taken in urging fresh enquiries and for

making the criticisms and recomendations I have, but the interest I continue to take in botanical work and the value, from a commercial, economic and climatological stand-point to the State, which both the Bassias alluded to in this report appear to afford will, it is hoped, be considered a sufficient excuse for my doing so.

It would be a failure of duty on my part, if I did not, with the information I possess and with the time at my disposal, take the opportunity, afforded by the reading of Mr. Pearson's extremely interesting paper, of emphasizing the great economic importance of *Bassia latifolia* and *Bassia longifolia* to the people of India, and also of bringing to notice the high financial value of their raw products to the State, and did not at the same time suggest the necessity of some organized efforts generally wherever the trees are now exploited for these products, to cope with the danger which exists of the trees becoming in the future extinct species, at any rate for all practical commercial purposes.

APPENDIX I—EXTRACT.

JOURNAL OF THE ROYAL SOCIETY OF ARTS, 1ST JUNE 1917.

MR. G. M. RYAN, F.L.S., late Indian Forest Service, urged the necessity for the preservation of the trees in India from which Mhoura seeds were obtained for the making of soap, margarine and candles. A danger existed that there might be a serious diminution in the numbers of that valuable tree, and it was most important that it should be regenerated. It was thought by some people in India that the growth of the tree should not be encouraged because it was a source not only of forest fires but also of intoxicating liquor. The natives burned the area around the tree in order to clear the ground so that the Mhouras might easily be collected, and the fires sometimes spread to the forest, but those difficulties might be overcome. The best trees produced about half a ton to a ton, which before the war fetched from 5 to 6 rupees per cwt. in the market, and in a good year the supplies were not available to meet the demand. Most of the seeds unfortunately went to Germany and to the south of France, and he thought special measures should be taken for improving and developing that important source of revenue to the Government of India, and especially that the product should be kept within the Empire.

APPEN-

Statement of the probable sources of supply of Mhoura Seeds from State exploitation were undertaken in

Sources of supply.		Forests in tons.	Waste lands in tons.	Price per cwt. in Rs.
1		2	3	4
BOMBAY PRESIDENCY.				
NORTHERN CIRCLE.				
Forest Divisions and Waste Lands.	Panch Mahals *not exploited* ...	1,600	...	1
	Surat including Dangs ...	400	...	1
	North Thana exploited ...			
	Central Thana „ ...	100	...	1
	South Thana „ ...			
Non-Forest Divisions.	Khaira District *not exploited*...	...	2,400	1
	Ahmedabad „ ...			
	Broach „ ...			
	Other Districts „ ...			
CENTRAL CIRCLE.				
Forest Divisions and Waste Lands.	Nasik exploited ...	500	...	1
	West Khandesh „ ...	1,000	...	1
	East „ *not exploited* ...	...	...	...
SOUTHERN CIRCLE.				
	Kanara	...	...	...
	Bassia longifolia chiefly *not exploited.*	Unknown	...	...
MADRAS PRESIDENCY.				
NORTHERN CIRCLE.				
Forests ...	Kurnul District *not exploited*...	500	...	8
Waste Lands ...	Kurnul District „ ...	...	500	8
BENGAL.				
Forests and Waste Lands.	Chota Nagpur ...	7,000	...	12
	Bihar and Orissa ...			
	United Provinces ...			
	Punjab			
	Central Provinces ...			
NATIVE STATES.				
	Baroda	12,000	...	12
	Rajputana			
	Indore			
	Hyderabad			
	Total ...	...	...	...

DIX II.

all India and the Estimated Income derivable therefrom if their Forests and Waste lands generally.

Value.	Total.	Total British India.	Total Native India.	REMARKS.
5	6	7	8	9
Rs.	Rs.	Rs.	Rs.	
32,000 8,000 2,000	... 42,000	... ...	... ...	It is necessary to explain that the figures entered in column 2 are based on the total average exports of seeds from all India as quoted in para. 6 of my Report. The details of quantities exported from each locality are approximate figures only estimated to the best of my ability. The average price of Re. 1 per cwt. entered in column 4 as the value of seeds in Bombay is not excessive, bearing in mind the fact that the net price obtained before the war in Khandesh sometimes exceeded Rs. 2 per cwt. The estimated outturn of 400 tons from Surat and the Dangs may be considered too sanguine since only a small income from Mhoura is now realized in Surat—but this is probably because of the duty of 1 anna per maund levied by the State on Mhoura. It would be preferable to forego the paltry revenue of about Rs. 100 annually here and to farm out the collection of the produce instead, permitting the people to collect the produce for sale free of charge
48,000	48,000	...	...	
10,000 20,000	30,000	...	...	
...	...	1,20,000	...	
...	10,000	10,000	...	
...	1,05,000	1,05,000	...	
2,80,000	...	...	1,80,000	
...	...	2,35,000	1,80,000	

IS SPIKE DISEASE OF SANDAL (*SANTALUM ALBUM*) DUE TO AN UNBALANCED CIRCULATION OF SAP?

BY K. R. VENKATARAMA AYYAR, EXTRA-DEPUTY CONSERVATOR OF FORESTS, MADRAS.

The most interesting and instructive article, on the cause of spike disease of Sandal, contributed to the October number of the *Indian Forester* by Mr. R. S. Hole, is so full of convincing arguments in support of the theory he has advanced, that it seems necessary to examine and find out how far the facts ascertained in the Sandal areas elsewhere will bear out his theory.

2. In his able article, Mr. Hole, who has gone to the very root of the question, has explained why he believes that spike is apparently not really infectious. My acquaintance with spike in Sandal dates from the year 1903 and having watched the progress of the disease in areas where I have worked, I feel that the reason given against the infection theory is sufficiently convincing. But the only point on which an explanation is, perhaps, necessary is why, if spike is due to natural causes such as those mentioned by Mr. Hole, the disease was not known to affect sandalwood anywhere prior to the year 1898, when it was first discovered in Coorg. The natural causes such as fire, damage of hosts and suppression must have also existed then, and unless it be that Forest Officers were less observant at the time than later, the absence of the disease during the earlier period would appear to remain unaccounted for. I do not think it can be seriously contended that the rapid spread of lantana, in recent years, has brought about new conditions favourable for the appearance of spike, as this disease is known to exist even in areas where no lantana grows.

While it is not my purpose in this article to discuss whether spike is or is not an infectious disease, I feel I have to place on record certain observations which have been made in the Sandal areas in the South Vellore Division, as they do not appear to support the theory advanced by Mr. Hole, that the disease is due to an unbalanced circulation of sap caused by a number of different factors which are said to be primarily—(1) Fire, (2) Death

or damage of hosts, (3) Partial suppression, and (4) Exposure of trees hitherto growing under shade.

3. For the experimental proof or otherwise of the theory, Mr. Hole has suggested a few simple forest experiments of which he has given six examples. A few experiments, somewhat on the lines of those indicated by him, have been carried out in the Sandal areas of the South Vellore Division, and though it is perhaps too early yet to draw any definite conclusions therefrom, I think that the facts hitherto ascertained might be stated so as to invite criticism. I must, at the outset, state that spike disease has not yet made its appearance in Sandal anywhere in the areas in the South Vellore Division, though *Zizyphus Œnoplia* is commonly found spiked, and has long been known to be spiked everywhere. The annual rainfall in the locality is about 40 inches.

4. The experiments carried out in the Division were designed to find out the effect of :—

(1) Isolating the Sandal tree from all possible hosts.

(2) Injuries of various kinds to the root-system of Sandal.

(3) Girdling the Sandal, and

(4) Exposing Sandal trees hitherto buried up under a dense mass of creepers.

In addition to these experiments, observations have also been made in the forest, to find out the health condition of the Sandal trees which were very seriously damaged by a violent cyclone that passed over the area in November 1916, which, in nearly every case, appears to have produced an unbalanced circulation of sap in the tree without actually producing spike in it. It is the purpose of this article, therefore, to summarize the results of these observations.

5. The first of the experiments was carried out to ascertain if Sandal was an obligate root-parasite. With this object, one Sandal tree 18 inches in girth, which had no other tree or shrub within a radius of 12 feet, was selected in February 1916 and a trench was dug to a depth of 2 feet all round it. This depth was increased in September 1916 to 3 feet where the soil is hard kankar. The diameter of the platform enclosed by the trench is 16 feet. The

section of the cutting made for the trench showed that no lateral roots of any species were embedded in the ground lower than about 1½ feet from the surface. At the same time as the tree was entrenched, the platform enclosed by the trench was dug up, and all surface roots of grass, etc., were removed from it, and every possible precaution was thereafter taken to keep the platform always absolutely clean and prevent any weeds or grass from growing on it. In cutting the trench round this tree (Tree No. 1) all its lateral roots were cut through with the result that the tree was entirely isolated and deprived of any possibility of getting the necessary water-supply from its hosts.

In August 1916, *i.e.*, six months later, the same experiment was tried on six other Sandal trees (girths varying from about 11 to 15 inches) in the immediate vicinity of tree No. 1 and, in all cases, the trench was carried down to a depth (mostly 3 feet) where the subsoil was very hard and where no lateral roots of any other species were found embedded. All the seven isolated Sandal trees, which had all their lateral roots cut through, are situated in a fenced area, and, fortunately for the experiment, none of them were blown down by the cyclone in November 1916 though their roots were violently shaken by it.

6. Mr. C. E. C. Fischer, the then Principal of the Madras Forest College, at whose encouragement this experiment was started, very kindly inspected the trees in September 1916 and recorded his observations on the then health condition of each tree. He had then remarked that four of the trees presented only an average appearance of health, while three others looked unhealthy. *In most cases, the crowns were small, the foliage was* incomplete and a number of dead twigs were found at the ends of branchlets. In recording these observations, he had also noted that these seven Sandal trees did not materially differ from the generality of Sandal trees in the immediate vicinity. All the seven trees have their crowns free and fully exposed to the sun. All except one tree were found to have their normal apical growth, with a full length of cambium and conducting tissue, though the foliage, in most cases, was deficient at the time the experiment was

started in February and September 1916. In the case of one tree only, there was some sign of stag-headedness.

It will, therefore, be clear that the test made is a very severe one and is calculated to deprive the tree of any chance of drawing its water-supply from its hosts, and thus to bring about the condition sufficient for an unbalanced circulation of sap. In every one of these cases, the rate of upward flow of water must have been diminished by the damage to the roots of the Sandal and of its hosts.

The experimental plot is situated in the head-quarters of a Deputy Ranger who is required to inspect the trees at least once a week, and submit a certificate at the end of it to say that the platform was kept clean and the trench was in order. Between September 1916 and January 1918, the trees were inspected twice by the Conservator of Forests, Mr. P. M. Lushington; first in December 1916 and afterwards on the 20th January 1918, and on both these occasions he was pleased to record his observations on *their health condition in the District Sample Plot register.* I have myself personally watched the progress of these trees every three months and noted down my observations on the spot in the Sample Plot register. The Conservator of Forests personally satisfied himself with the precautions taken to prevent the possibility of any weeds, etc., from growing on the platform enclosed by the trench, in the case of each Sandal tree experimented on. The very hard beaten nature of the surface of the platform is sufficient testimony to its being continually trodden upon for the purpose of examining if any weeds grow upon it. Every time an inspection was made, the fact whether the platform was clean was noticed and a record that it was so was invariably made. It was also observed on examining the section of the cutting on the inner edge of trench that all embedded roots of species other than Sandal had died out.

7. In all these cases, most magnificent reproduction from root shoots has appeared on the outside edge of the trench, the shoots coming out of the cut ends of the lateral roots of the entrenched Sandal, whose haustorial attachments outside the

trench had not been severed. In some cases, root shoots appeared on the inner edge of the trench, but they were found to belong to other distant Sandal trees which had sent their lateral roots towards the entrenched Sandal trees. These shoots, however, all died out at an early stage.

The entrenched Sandal trees, seven in number, have, up to date of writing this article, shown no sign of spike though one tree has remained in complete isolation now for two years and the others for one year and six months. A photograph of the former, which (Plate 19) was taken for me by Mr. C. Srinivasa Rao, student of the Madras Forest College in October 1917, will show the present health condition of it. On 20th January 1918, the same tree was inspected by the Forest Commissioner who was pleased to take a photo of it, to show the platform, the trench and the magnificent root shoots growing on the outside edge of trench.

The above experiment, in addition to showing the remarkable vitality of Sandal, seems to show that the unbalanced circulation of sap, which must necessarily have been caused by isolating the trees and cutting through the roots by deep trenches thereby greatly diminishing the supply of water and nourishment, has not produced spike.

8. The other experiment that was carried out is in the compound of the Forest Rest-house at Andiappanur and was started on 4th September 1916. Four very healthy Sandal trees planted in 1904 alongside the live fence of the bungalow compound were selected for the experiment. The lateral roots, in the case of every tree, were exposed one after another and strong sulphuric acid was injected into them at various intervals along their whole length. In addition to this treatment, all root attachments were severed in the case of one tree, and in the case of two others the removal of the haustoria was followed up by cutting out the ends of all lateral roots and rootlets. After these operations were performed, the roots were covered up again with earth. There was practically no change in the health condition of any of these four trees when they were inspected in December 1916, and also thereafter at the end of every three months. The trees were last inspected by the

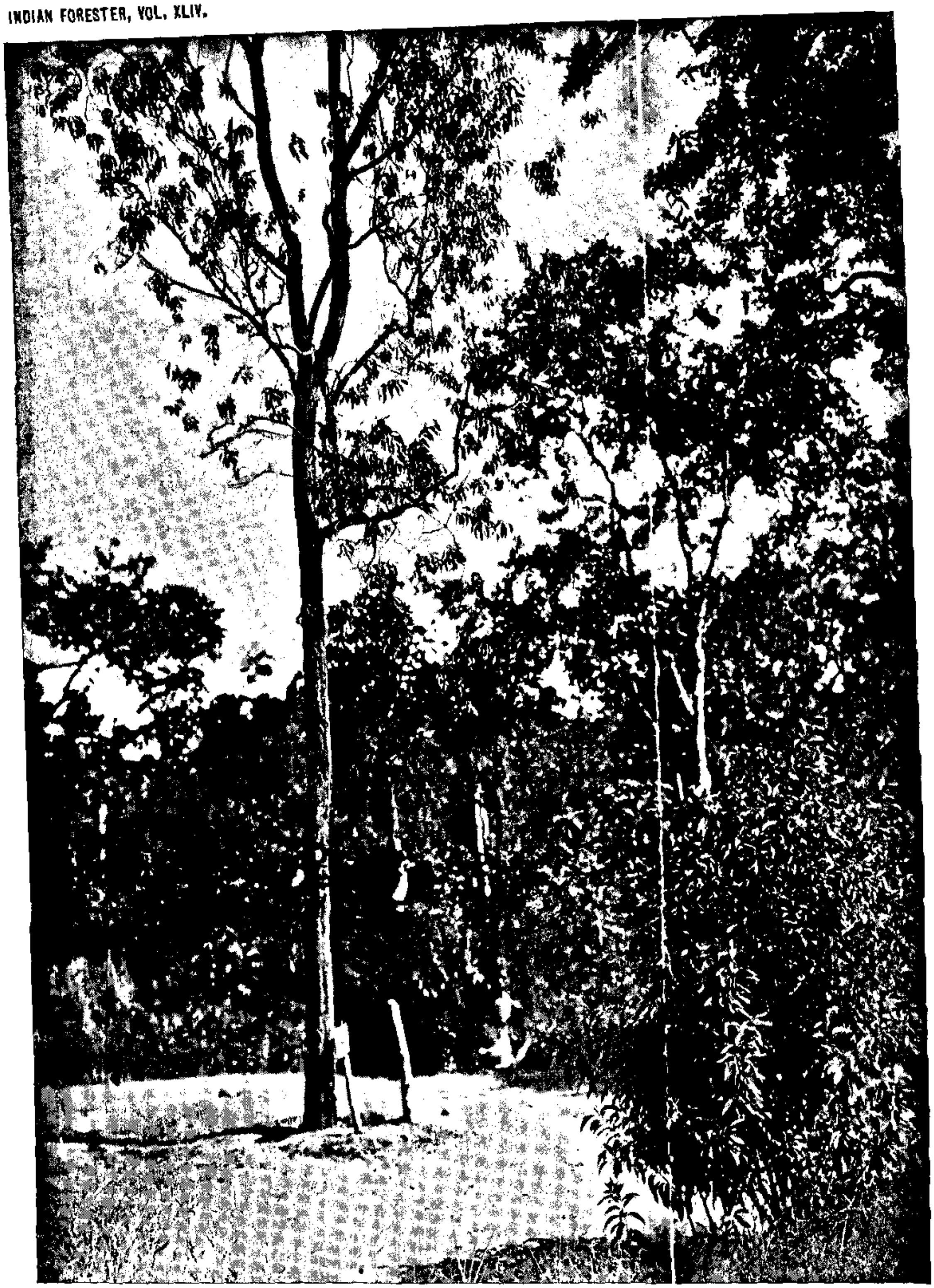

Photo-Mechl. Dept., Thomason College, Roorkee. Photo by C. Sirinivasa Rao, October 1917.

Sandal tree isolated in February 1916. View showing the trench dug to isolate the Sandal tree and the platform kept free from grass, etc. South Vellore Division, Madras.

Conservator of Forests in November 1917, when these were found to be generally very healthy with dark green leaves and abundant foliage. The lateral roots of these trees were then again exposed one after another under instructions of the Conservator of Forests when the effect of the past maltreatment was closely studied. It was then found that wherever a severe injury was caused to the root, either by the injection of the sulphuric acid or by the cutting away of the root-ends, fresh roots have grown out from the injured places which had, within a short time, made most marvellous growth in length and secured, in some cases, new attachments. In November 1917, much more severe injuries were made to the roots which were again covered up and the result is being carefully watched. The injury done to the lateral roots, in the case of these four Sandal trees, in September 1916, is perhaps not less severe than the damage by fire to the roots which is considered likely to produce spike. The amount of maltreatment done to the roots in September 1916 should, in my opinion, have been sufficient to cause an unbalanced circulation of sap in a tree which till then was growing under the most normal conditions and yet none of the trees was spiked.

In a 5-acre plot at Amerdi containing 20 to 30 Sandal trees per acre, teak was planted during May and June 1917. In the hot weather of that year all trees other than Sandal in that plot were felled for the purpose, and their roots grubbed out. After the removal of the felled trees, all the unsaleable brushwood was made into heaps which were scattered about the area and they were fired. The fire was so intense that, in some cases, the neighbouring Sandal trees were killed outright, whilst others were badly scorched by it. These latter were, for some time, bare of leaves which wilted away, but with the first burst of the monsoon in July, new flush began to appear and the trees, in most cases, have put on their normal foliage. In no case was spike observed as a result of this firing. The same operation in another 5-acre plot was carried out in 1916, immediately adjoining the 1917 plantation where there was an equally large number of Sandal trees, and none of the Sandal trees that survived got spike. It must,

In this connection, be said that the Sandal trees about this locality were tall luxuriantly grown ones on an alluvial soil and, before the clearing was made for the plantation, every one of the Sandal trees was growing amidst good hosts with plenty of lateral shelter and overhead light and with good normal crowns and foliage, The sudden removal of all the hosts which were, for the most part, grubbed out and the subsequent injury by fire caused to the roots and lower portions of the stem of the Sandal trees that survived the fire, should, I think, have produced all the conditions necessary for an unbalanced circulation of sap, but spike has all the same not been observed in anyone of the trees.

9. The third experiment, *i.e.*, girdling healthy Sandal trees, was *started in the year 1913 with a view to find out if it would tend* to an increased production of heartwood. Six very healthy trees of about 36 inches girth were selected for the purpose and the girdling was made in each case right into the heartwood. Periodical observations were made and it took nearly three years for the trees to completely die, and even then it was the portion above the girdle that dried up in each case and not the portion below it. In none of these cases was the tree observed to be spiked, though an unbalanced circulation of sap must probably have been caused in each case as a result of girdling, which must have interfered with the translocation of the organic food by reason of the stoppage of water from the roots. In the Chengam Range of the West Vellore Division, where dying Sandal trees are systematically being girdled for extraction two years later, no spike has up to date been observed. All girdling in these cases is carried out at the base of the tree. This, in practice, must have, in my opinion, the same effect as causing serious injury to the roots as in both cases, the upward flow of water must either cease or diminish greatly so as to produce an unbalanced condition in the circulation of sap. In the case of a Sandal tree girdled deep into the heartwood at its base, the upper portions of the tree must obviously depend on the tissues of the stem above the girdle for the supply of water, and this being insufficient for the growth, and nourishment of the long length of cambium above the girdle and for the translocation

of carbohydrates, an accumulation of carbohydrates must soon result in the leaves leading to spike, according to the theory advanced by Mr. Hole, if I have correctly understood the exact significance of the term "Unbalanced circulation." This, however, has not been the case and the tree died slowly without any outward sign of spike.

10. The exposure of Sandal trees growing under suppression forms part of the prescriptions of the Sandal Working Plan in the district; and under this Working Plan which came into force in 1915, thousands of Sandal trees which till then were buried under creepers were systematically relieved from suppression. Trees treated in this way were inspected by the Conservator of Forests, Mr. P. M. Lushington, who writes thus in his Inspection Note dated 21st December 1916: "The crowns of all trees in the tended area are now released, and it is only necessary to see the large number of trees with poor crowns to judge how they have been overwhelmed with creeper." In spite of such sudden exposure of these trees and the increased loss of water which must have occurred from the transpiring leaves of a disproportionately small crown and a poorly nourished cambium of the tree which had long remained under suppression, spike has not appeared in any single case. Nor has this prolonged suppression of Sandal by creepers or other growth ultimately caused spike in any single case up to date in the Sandal areas of the South Vellore Division.

I have, in the foregoing paragraphs, attempted to show how the theory advanced by Mr. Hole is not in accordance with facts ascertained in the Sandal areas of the North Arcot District. Every one of the four primary factors believed by him to cause spike has not so far been able to produce spike in Sandal in the area under reference. It is possible that the experiments have not been carried out on the exact lines suggested by Mr. Hole and do not justify the present conclusion, but it is hoped that defects, if any, in the experiment will be pointed out.

11. The cyclone of the 22nd November 1916 did enormous damage to the Sandal trees in the North Arcot district and

Mr. Lushington in his Inspection Note, dated 21st December 1916, thus tersely describes the damage:

"Everywhere in the patta fields, the porambokes, the wastes and the reserves, trees of every description have been blown over or completely topped. In other cases, *limbs large or small have been* blown off. * * * "

"Many trees have been completely uprooted, others have been torn from the ground and are leaning over and nearly every tree has been badly shaken. Some trees are completely bereft of their crowns, others have lost a large limb and others still have limbs broken and the leaves blown off. There is hardly a tree left standing that has not received damage in some way or other."

All irretrievably damaged trees were removed but, in a large number of cases, trees still continue to live apparently in best of health, even where all but a single lateral root had been completely exposed and the tree itself blown down. With such great injury to most of the roots which have lost all their attachments, the trees continue, in many cases, to live apparently in best of health and produce dense foliage. These are, I suppose, instances where an unbalanced circulation of sap in the tree must have resulted but without the trees getting the disease. In a large number of other forms of injury caused by the cyclone to the roots, stems and branches of the Sandal tree, no spike has appeared though, in some at least of those cases, an unbalanced circulation of sap must have set in.

I, therefore, venture to ask whether, in these circumstances, the spike disease of Sandal is due to an unbalanced circulation of sap and *if so, whether it is caused by the four primary factors* alluded to by Mr. Hole.

SPIKE DISEASE OF SANDAL.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

1. Mr. Venkatarama Ayyar's article on the cause of spike which is published in this number of the *Indian Forester* is a most interesting and valuable one, inasmuch as it records the results of careful experiments designed to test the effect of individual factors on the health of Sandal and describes the conditions under which the experiments were carried out. It is by work of this kind that the various causes of spike which have been suggested from time to time can be satisfactorily tested and that real progress in our knowledge of the disease is likely to be secured. At the same time such progress must be retarded if we reject possible causes on insufficient evidence and shut down experiments regarding them before they have been thoroughly and exhaustively tested. In the hope that they may encourage the extension and continuation of such experimental work, the following notes are offered on the various points raised by Mr. Ayyar :—

2. *If spike may be caused by natural causes why did it not appear before* 1898. The fact that spike in Sandal was first brought prominently to notice in 1898-99 is no proof that the disease originated about that time. Attention has only recently been drawn to the occurrence of spike in *Zizyphus Œnoplia* but inquiry has now shown that this disease occurs practically throughout the Peninsula of India and it has almost certainly been in existence for a long period. Although *Trametes Pini* was first definitely reported in India in 1904, there is no doubt that this fungus was widely distributed in the Punjab hills long before this date. The fact that spike in Sandal first attracted serious attention in Coorg in 1898-99 may merely indicate that, in that locality, at that time, spike had become unusually prevalent and if so, in Coorg at any rate, this unusual prevalence appears to have been coincident with the spread of lantana.

3. As regards the bearing of Mr. Ayyar's experiments on the theory that spike may be caused by an unbalanced sap-circulation, a reference to pp. 430, 431 of the *Indian Forester* for October 1917

will show that this theory postulates a condition under which carbohydrates accumulate in the leaves and branches and that this condition should be *prolonged.* That various factors may be responsible for an unusual accumulation of starch in the above ground parts of green plants is well known and among such factors are a deficiency of an essential nutrient substance, an acid soil, a deficiency of water and interference with the translocation of organic food. Sucking insects and the hyphæ of various fungi are probably also able to produce carbohydrate accumulation partly by the actual abstraction of moisture from the plant cells and partly by damage to the conducting tissues. The point which requires to be proved is whether this carbohydrate accumulation can be carried to such a point as to produce the pathological condition known as spike. To test this theory, therefore, it is necessary to select one of these various factors, to arrange the conditions of the experiment in such a way that the intensity of the factor is sufficient to cause an accumulation of carbohydrates and finally to see that this condition is *prolonged.* Until these conditions have been fulfilled the theory cannot be said to have been tested.

4. Mr. Ayyar's first experiment deals with the isolation of Sandal trees by means of trenches. If it is subsequently proved that the roots of other plants have been effectively excluded from these enclosed areas and that the isolated trees remain healthy for a considerable period, the results obviously indicate that Sandal is not an obligate parasite but can, under some conditions at least, obtain its supplies of water and salts from the soil by means of its own roots. Some experiments which are being now carried out at Dehra Dun appear to point to the same conclusion and it is quite possible that in some localities Sandal is more independent of host plants than in others, on account of better, moister soil, heavier rainfall or other conditions. Assuming that Sandal can maintain itself without host plants in the locality, the cutting of the lateral roots 8 feet from the tree might do no more than cause a temporary decrease in the water-supply which would rapidly be made good by a vigorous development of adventitious roots. It

is obviously important to watch the future development of these isolated trees, to record their girth development and compare it with that of similar control trees in the neighbourhood and also to see whether or not the treatment has any effect on the starch content of the leaves and twigs. I would also suggest that similar experiments should be carried out in different localities on different types of soil to see whether the dependence on host plants does vary. In one case at Dehra Dun the removal of host plants has been followed by a stag-headed condition, while in another case the effect has been more gradual with less stag-head accompanied by a marked accumulation of starch in the leaves. So far as possible, the experiments should aim at producing and prolonging this latter condition. In localities where Sandal is mainly dependent on host plants the sudden and entire removal of all the latter would be more likely to cause death or stag-head. The gradual killing of the principal hosts near the Sandal trees, perhaps by girdling, would probably give the best results. With reference to this point it is interesting to note that Mr. Tireman has recently visited a place in Coorg where a spiked Sandal was discovered a year ago. This is over 3¾ miles in a straight line from the nearest previous attack and is separated from the latter by a hill range, the lowest point of which is 500 feet above the average level of the country. The attacked tree was practically touching an *Albizzia stipulata* which is now nearly dead and which Mr. Tireman thinks has been dying for 2—3 years. The roots of the *Albizzia* were extensively rotted by a fungus which could not be identified owing to the absence of sporophores.

5 As regards damage by fire Mr. Ayyar quotes two cases where severe burning has produced no spike. The writer has also seen several such cases. In *Indian Forester*, 1917, page 433, an attempt was made to explain that it was only under certain circumstances that fire seemed likely to produce the conditions necessary for spike, *i.e.*, when the damage was such as to diminish the water-supply and interfere with the translocation of organic food without materially damaging the upper portions of the stems and branches. With reference to this point it is remarkable that spike

in Sandal is worst in Coorg in dry stony areas subject to fires and densely stocked with lantana. In such localities lantana does not attain a great height but forms a low very inflammable cover. The roots of lantana, also, which are here extensively parasitised by the Sandal are very superficial while the stony dry soil naturally renders these roots more liable to fire damage than would be the case in a deep moist soil. Here, therefore, we have a combination of factors which would render fire most effective in retarding the water-supply and the translocation of organic food without seriously damaging the upper portions of the stem and branches of Sandal. In *Indian Forester*, 1917, p. 438, therefore, it is stated that the fire experiments should preferably be conducted in "dry localities with a small rainfall or shallow stony soil well stocked with lantana." This remark refers to Coorg which I have personally seen, but in other districts where lantana sheds its leaves in the hot season it is possible that fire may not be severe enough to cause spike. In any case it is obviously advisable to burn for at least two years in succession and, if possible, to compare the starch content of sample trees in the burnt areas with that of control trees in unburnt areas.

6. The writer has seen cases in the field where mere cutting and local injury to the roots of Sandal has been followed by a strong growth of vigorous adventitious roots. Such damage, if severe, might be sufficient to cause a condition of stag-head but the shortage of water would soon be made good by the additional adventitious roots and it would apparently be difficult to produce in this way a prolonged condition of slightly deficient water-supply such as is believed to be one of the causes of spike. No experiments on these lines, therefore, were suggested by the writer and it is interesting to note that Mr. Ayyar's experiments in cutting and injuring roots and his observations on damage to roots by a cyclone indicate that spike is not easily caused in this way.

7. Mr. Ayyar points out that, although thousands of trees have been freed from suppression in the South Vellore Division and large numbers of Sandal have been there exposed to prolonged suppression, no single case of spike has occurred among them. The same remarks apply equally well to considerable areas in

Coorg but this does not alter the fact that in many of the dryer forests of Coorg there does appear to be a distinct connection between the incidence of the disease and a condition of slow suppression in which the lower branches and twigs are slowly but steadily killed off although the apical growth of the upper branches still continues. Also in such areas, so far as can be judged by direct field observations, sudden exposure of the upper branches to full sunlight certainly appears to favour the disease. Experiments have now been initiated in Coorg, the object of which is to definitely prove whether or not suppression and the exposure of suppressed trees does here increase the incidence of the disease but detailed study of the effect of suppression, under varying conditions of growth, on the accumulation of carbohydrates in the plant will be required before we can hope to arrange our experiments in such a way as to produce spike by suppression at will, under varying conditions of soil, climate and growth.

8. Mr. Ayyar also points out that girdling Sandal trees into the heartwood resulted in the death of the portion of the trees above the girdle and not in spike. The writer has seen no cases which indicate that spike can be caused by girdling and no experiments in this direction were proposed by him. Sudden and drastic interference with the water-current such as would result from girdling to the heartwood would naturally be expected to produce stag-head as in the case of severe damage by drought. At the same time a method of girdling which interferes with the translocation of carbohydrates without suddenly checking the water-current might, possibly, in time produce the disease by causing an excess accumulation of carbohydrates above the girdle, a gradual starving of the roots and a slow diminution of the water-current. It would, therefore, be interesting to try the effect of girdling by removing (*a*) bark alone and (*b*) bark with some of the outer sapwood. It would be necessary to prevent the development of leafy twigs and branches below the girdle as well as the production of root-suckers.

9. In March 1917, the writer circulated to officers interested in this question of the spike disease a preliminary note on spike and the following extracts are taken from that note :—

"The fact which struck the writer most forcibly during the present tour was the extraordinarily widespread damage to the crowns of the trees caused by the dying back of the twigs. * * This kind of damage, while as a rule only slightly, if at all, checking the apical growth of the branches, results in an abnormally thin crown containing quantities of dead twigs and is, therefore, different from the condition usually called "stag-headed," which is characterized by the death of entire branches from the apex downwards * * Judging from the limited areas and number of spiked trees seen during the present tour, it appears to be a fact that, in Coorg, spike does not as a rule appear in a plant which hitherto was perfectly healthy and had developed normally but follows after a more or less extensive and repeated damage to the twigs. If the branch of a healthy Sandal tree is examined it will be seen that, accompanying the continued apical growth of the branch, is a correspondingly vigorous development of lateral twigs from the older portions of the branch. To some extent at least, these lateral twigs must be responsible for the nutrition of the cambium in the older portions of the branch and for the continued production of new and effectively conducting tissue for the transport of water in the wood upwards to the terminal twigs and for the translocation downwards in the bast of the organic food material manufactured in the leaves of the terminal twigs. It seems possible, therefore, that interference with this normal development by the repeated killing off of the lateral twigs may result in abnormal apical development coupled with more or less stagnation of growth in the older portions of the branches. The latter would cause a slowly decreasing water-supply to the terminal twigs and a gradual accumulation of organic materials such as starch in the twigs. Such a condition of affairs would sooner or later result in the death of the roots from starvation and thus the two chief characteristics of spike might be produced. * * The factors (causing the damage to the twigs) which at present appear to deserve most attention are:—

(1) *Insects.* Signs of damage done apparently by sucking insects, probably scale insects or aphids, were frequently found on the damaged twigs. * *

(2) *Parasitic fungi.* Many of the dead twigs contained the hyphæ of an apparently parasitic fungus. This requires to be identified and its connection, if any, with the fungus commonly seen on the peduncles of lantana carefully studied. * *

(3) *Bad soil aeration.* * * *

Finally, it is interesting to note that the specimens of spiked *Zizyphus Œnoplia* obtained during this tour indicated that in this species also, in the specimens seen, the first appearance of spike was preceded by the death of the lateral twigs. In the dead twigs the hyphæ of a fungus have been found, but whether this is the primary cause requires further study."

10. A subsequent tour in Coorg brought to light cases of spike in Sandal in which there was no marked previous dying of the twigs but which appeared to be correlated with the gradual death of neighbouring host plants. In order to include cases of this kind and at the same time to afford a reasonable explanation of the other known facts, the theory was then put forward that spike was due to a prolonged condition of unbalanced sap-circulation which might be due to a deficient water-supply, to any factor which retards growth without interfering with photosynthesis, *e.g.*, a deficiency of an essential nutrient substance like phosphorous, or which interferes with the translocation of organic food, *e.g.*, damage to the conducting tissue of the cortex (*Indian Forester*, 1917, pp. 430, 431). At the same time stress was again laid on the importance of the death of the lower lateral twigs and the apparent effect of fire damage and suppression in this connection (*l.c.*, pp. 431—434).

11. The writer has recently studied an area near Dehra Dun, where spike in *Zizyphus Œnoplia* is very prevalent and where, so far as can be judged from direct observations in the field, spike follows after a more or less prolonged period of damage to the lower lateral twigs, just as has been seen to be the case in Coorg. In the present case, however, the area in question is not subject to fires and the damage is apparently due to a fungus, the hyphæ of which are found in the leaves and twigs. The fungus associated with this damage has not yet been definitely identified but is

possibly a species of *Cladosporium* or *Phoma.* Whether or not the fungus is the primary cause of the damage remains to be proved by inoculation experiments. A number of plants showing this type of damage are now in cultivation in the Dehra garden where they are being kept under careful observation and the effect tested of endeavouring to keep some of the plants free from the fungus by removing the damaged twigs and spraying. Plate 20, fig. 1, shows a branch of *Zizyphus Œnoplia* collected in Coorg which shows the commencement of spike following extensive damage to the lower twigs. Plate 20, fig. 2, shows a branch of the same species collected near Dehra Dun in which spike has also followed the death of the lower twigs, the apical portion of the branch being still healthy. Plate 21 shows *Zizyphus Œnoplia* plants now growing in the Dehra garden which are not yet spiked but which show the death of the lower laterals, the upper twigs being still healthy. The continued checking of growth and interference with normal nutrition in the lower portions of the stems would be expected to cause a local accumulation of carbohydrates which would tend to be increased by the failure of the poorly nourished conducting tissues to carry away rapidly to the roots the organic food manufactured in the uninjured upper branches. These cases indicate the importance of leaf and twig destroying fungi as one of the possible causes of the disease and it is hoped to pay special attention to this point during the coming rains and with special reference to the connection, if any between the fungi occurring on Zizyphus, Sandal and Lantana and also to the effect of such factors as water-supply, fire and suppression on the development and injurious action of these fungi. It should be noted that the possible importance of fungi in connection with spike was first emphasized by Mr. H. A. Latham who, in a letter to the writer, dated 4th August 1915, pointed out that spike was associated with the death of the leaves, flowers and twigs and the appearance of fungal sporophores on the leaves and flowers. Specimens of the fungus, however, were not sent to Dehra. In the Madras Presidency Annual Forest Report for 1915-16, p. 22, also, Mr. Latham wrote: "Careful inspection with a lens of leaves and flowers which have recently died on spiked

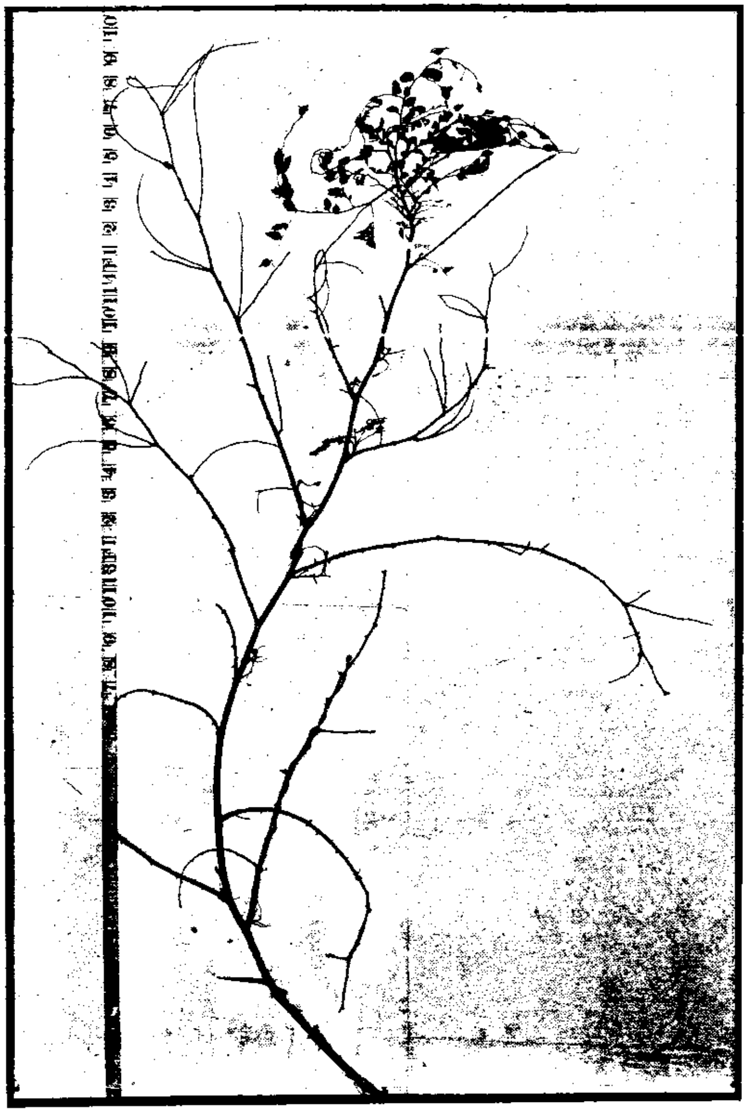

Photo-Mechl. Dept., Thomason College, Roorkee.

Fig. 1. Branch of *Zizyphus Oenoplia*, collected in Coorg, which shows spike appearing subsequently to extensive damage to the lower lateral twigs. At the extreme apex the twigs are still healthy.

Fig. 2. Branch of *Zizyphus Oenoplia*, collected near Dehra Dun, showing healthy twigs at apex and spike below following damage to the lower lateral twigs.

trees in wet weather often shows black sporophores with spores attached; whether these follow or cause spike, the writer is unable to say; he thinks the first sign of spike is the death of individual inflorescences as a whole and their not falling, normally the flowers appear to drop one by one often before they are quite dead."

12. With reference to the above suggestion that fungi are a possible cause of the disease, it may be asked why, if this is so, has the fact escaped the notice of those mycologists who have already studied the disease and why has this possibility been negatived by practically all those who have studied the disease up to date? The following points, it is believed, supply the answers to these questions and also indicate how the various difficulties are met by the theory of an unbalanced sap-circulation:—

(1) The primary damage done in causing the death of the attacked leaves and twigs is apparently quite insignificant and does not, as a rule, immediately result in spike. The damage done, in fact, is apparently often made good by the production of new normal leafy shoots from dormant buds. Such damage does not give the impression of being at all serious in the case of plants like Sandal and *Zizyphus Œnoplia* which are notoriously resistant to damage by mutilation. At first sight, therefore, the possible effect of repeated and gradually extending damage of this kind on the nutritional processes of the plant as a whole and especially on the sap-circulation and movements of carbohydrates is not evident and might be easily overlooked.

(2) The fungi apparently responsible for the damage are often found on trees which are not yet spiked. Under the theory of an unbalanced sap-circulation, however, spike is believed to be the final result of a prolonged injurious action and damage by such fungi would, therefore, be noticeable some time before the appearance of spike. It must also be remembered that the damage done by such fungi almost certainly depends to a considerable extent

on the vigour of individual plants and whether or not the conditions for their growth are favourable.

(3) If the disease is due to a fungus which is a strong parasite capable of attacking perfectly healthy individuals, we should not expect to find plants remaining apparently healthy for considerable periods which are in the immediate vicinity of spiked individuals, yet this does undoubtedly happen in the case of Sandal. This, however, may quite well be explained by the fact that many fungi can only gain an entry into the tissues of a plant when the latter is already in an unhealthy condition or when an area of dead or wounded tissue facilitates an entrance. In the case of such fungi grafting would probably facilitate infection.

(4) In some spiked individuals fungi may apparently be absent. According to the theory of an unbalanced sap-circulation, however, spike may be caused not only by fungi but by the prolonged action of various factors which are able to cause an accumulation of carbohydrates in the leaves and twigs.

13. In conclusion, while urging the importance of an extended scheme of carefully designed experiments to test the effect of the various factors which have been suggested as possible causes of spike, the writer would emphasise the desirability of not confining these, as is sometimes suggested, to those areas where spike is not yet known to occur. We want to know not only what factors are able to give rise to spike in areas where spike has not yet occurred but also what influence the various factors have in increasing the virulence of the disease in areas which are already infected. One of our chief objects is clearly to discover as quickly as possible a practical means of preventing, or, at all events, of decreasing the incidence of the disease and in this connection such experiments as those of Mr. Tireman which have shown that eradicating lantana may reduce the incidence of the disease by 50 per cent are obviously of the greatest importance.

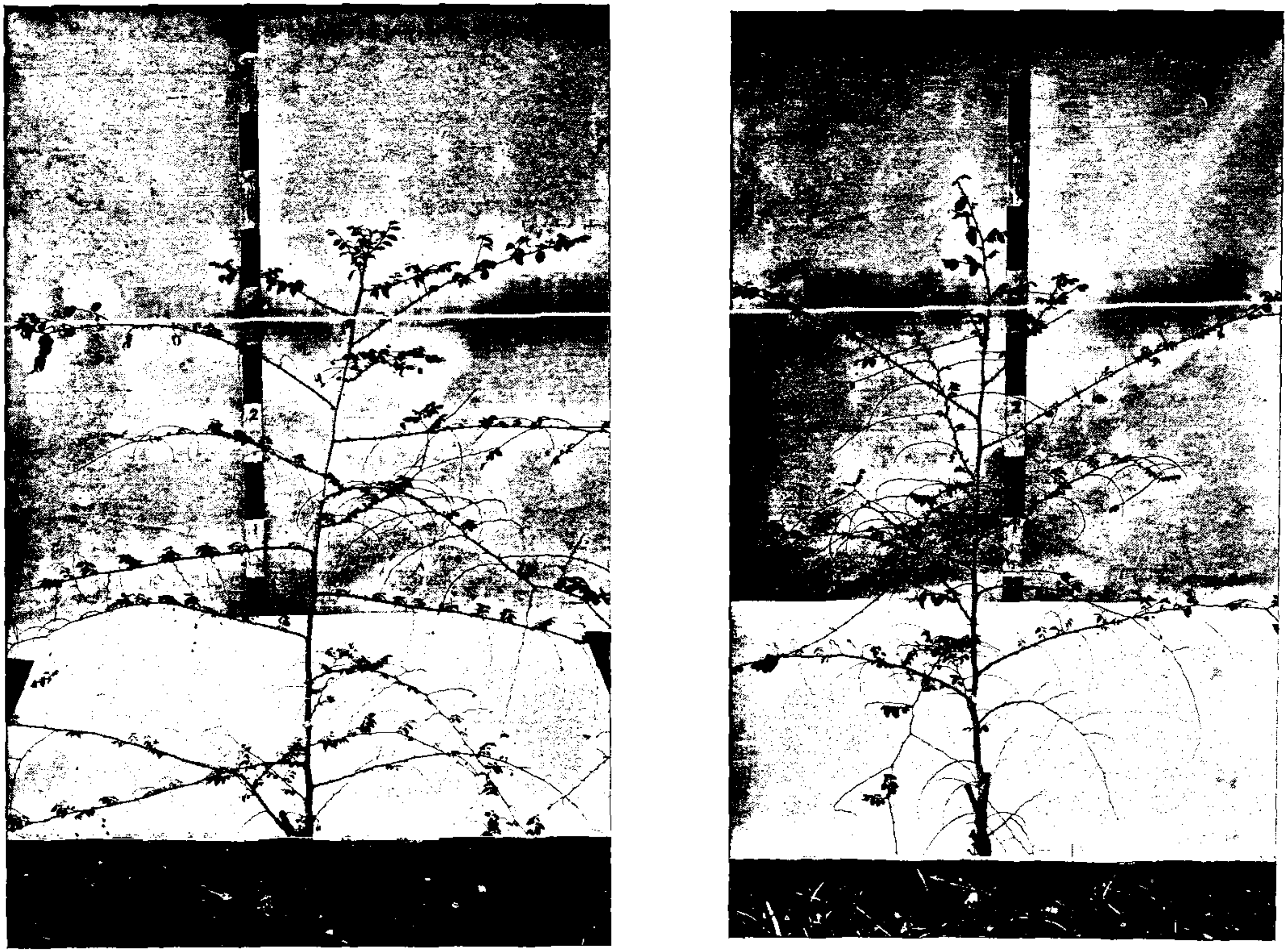

Photo-Mechl. Dept., Thomason College, Roorkee.

Plants of *Zizyphus Oenopiia* growing in Dehra Experimental Garden. Photographed in April 1918. Note the extensive damage done to the lower branches and lateral twigs during the preceding rains believed to be caused by a fungus, possibly a *Cladosporium*. The terminal shoot and ends of the upper branches are uninjured.

HOW THE SINDHI FISHERMEN CATCH LIVE MUGGERS.

BY D. G. OMMANNEY, DISTRICT SUPERINTENDENT OF POLICE.

Mr. D. G. Ommanney, District Superintendent of Police, Thar and Parker District in Sind, gives a most interesting account of how the Sindhi Fishermen catch live Muggers. He writes:—

"We went to the tank about 5 minutes from the bungalow and found that the men had spotted one mugger and tied it up, and that it was lying on the bottom of the tank. They also offered to show us how they caught the beast, provided they could find another one. Two men went into the water, one with a rope and the other holding a long stick with a blunt fish-spear at the end, swimming about on large water-pots specially made for fishing. It is said that the muggers fear the water-pots, and when they hear the men swimming about on them, lie quiet at the bottom of the tank. They looked about till they spotted a mugger, and one pressed the spear on his back and held it there, not wanting to wound the beast as that might have infuriated him and so reduced the chances of catching him. We saw the man holding the spear down, and then the second man dived under the water to slip the rope round the mugger by tickling him gently under the body to make him raise himself, and so allow the rope to be slipped round him. They then began to pull in the rope with the help of the onlookers on shore, and gradually a huge monster was hauled to the bank beside us. They stuck a stick into its mouth and tied it up, while it bellowed. Some of the men hung on to the rope to prevent it going back into the tank, while others pulled the first one caught to shore. This one was about 7 feet long and the other was about 9 feet."

MEETING OF THE BOARD OF FORESTRY.

We understand that the Board of Forestry which met in March 1916 will hold its fourth meeting in March 1919, and that a representative from each province will be invited to attend. The Board will discuss the programme of the Research Institute for the next three years as well as any forestry problems that may be referred to it for advice.

Any subjects proposed for discussion should reach the Inspector-General of Forests not later than 1st December 1918.

KING-EMPEROR'S BIRTHDAY HONOURS' LIST, 1918.

We are glad to see that the following members of the Forest Department figure in the recent Honours' List :—

Commander of the British Empire :—Archibald Alexander Dunbar-Brander, Esquire, Imperial Forest Service, Divisional Forest Officer, Nimar, Central Provinces.

Members of the British Empire :—Rao Bahadur Shrinivasalu Naidu, Divisional Forest Officer, Nagpur, Central Provinces, and Mr. M. Narsing Rao, Provincial Forest Service, Divisional Forest Officer, Bhandara, Central Provinces.

Rao Sahib :—M. R. Ry. Kodumudi Ramaswami Venkataramana Ayyar Avargal, Extra Deputy Conservator of Forests, in the Madras Presidency.

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INDIAN FORESTER

AUGUST, 1918.

WALNUT BARK.

BY PURAN SINGH, F.C.S., OF FOREST RESEARCH INSTITUTE, DEHRA DUN.

The bark of *Juglans regia*, the well-known walnut tree, is mentioned in the text-books of Indian Economic Products as a rich tanning material and as a dye, but it seems it is not available in sufficient quantities to be used as such. Its chief use in the Punjab is as a dentifrice, and the writer being from his boyhood familiar with this use of the material was led to investigate its properties as a dental preservative. This short note, therefore, embodies suggestions for the utilization of this bark as a dentifrice.

The preliminary composition of two samples of the bark and one of the green pericarp of the ripe green walnuts was first determined with the following result:—

Description.	Moisture %.	Total soluble solids %.	Non-tannin %.	Tannin %.	Tannin calculated on dry material %.
(1) Green bark from the stem of a tree growing in the Forest College Gardens, Dehra Dun (after being shade-dried).	12·34	11·36	4 77	6·59	7·51

Description.	Moisture %.	Total soluble solids %.	Non-tannin %.	Tannin %.	Tannin calculated on dry material %.
(2) Another sample of the dried walnut bark, known as 1st quality, from the Amritsar market (apparently a mixture of the stem and branch barks).	9·79	16·40	8·04	8·36	9·26
(3) Fresh pericarp of the ripe walnuts.	83·0	9·12	7·03	2·09	12·23

It is well known that the green pericarp or the shell of the walnut contains a small quantity of the (α) hydro-juglone (the yield being 150 grams from 100 kilos) which oxidizes to *juglone* or oxy-(α) naphthaquinone. The aqueous extract both of the pericarp and the bark are acidic in reaction and reduce Fehling's solution. Both the pericarp and the bark, when distilled with steam, yield distillates which reduce Fehling's solution, though no formaldehyde could be detected. It appears that a mixture of juglone and (α) hydro-juglone distils over to some extent and reduces Fehling's solution.

The walnut bark No. 2 gave 2·18 per cent. of the ether extract after the latter was treated with the bichromate mixture which oxidizes the (α) hydro-juglone in solution into juglone. The crude juglone out of this weighed only 0·31 per cent.

Uses.

The suggestion has been made that this material might be utilized as a tan agent and as a dye. As regards its uses as a tan material, it is too poor in tannin and also too valuable to be used as such in the tannery. In times of scarcity of dye materials, it might be suggested for use as a subsidiary dye, by extracting the dye from it with ether, and oxidizing the etheric solution by means of bichromate mixture (10 parts bichromate of potash and 13 parts sulphuric acid in 500 parts of water) and using the crude ether extract for dyeing purposes. In the opinion of the writer, however, the high cost of extraction would not justify the results obtained.

This bark is prescribed by the Indian system of medicine for throat troubles, when it is required to be kept in the mouth allowing its extractives to act slowly on the throat, and there seems to be no doubt that, owing to the presence of tannic acid and (α) hydro-juglone, it cannot but act very beneficially on the throat. Though the germicidal properties of (α) hydro-juglone have not been investigated, it can be safely said that owing to the slow oxidation of (α) hydro-juglone in the mouth and the formation of juglone, it acts as a mouth and throat antiseptic. It would be interesting were the actual germicidal properties of (α) hydro-juglone investigated, as it is likely that, owing to its ketonic nature and reducing action which is similar to that of formaldehyde it might prove a valuable disinfectant in general.

As a dentifrice.

The writer is already aware of the use of this bark as a popular dentifrice by the womenfolk of the Punjab and the North-Western Frontier Province. It is there in daily use, and by this means the teeth are maintained in excellent condition to a very advanced age. In fact, it would be no exaggeration to say that the people who daily use this bark never have any serious trouble with their teeth. The way in which they use it is simple though crude. A small piece of the bark is masticated till it becomes quite soft, the teeth being then rubbed with it as with a brush. It thus readily removes the 'tartar' from the teeth which immediately become pearl-white. Trials have been made by the writer on teeth which had been neglected and allowed to become discoloured with 'tartar,' and the effect on them was similar. There is no doubt that the excellent effect on teeth is due to the combined presence of (α) hydro-juglone and tannic acid, the latter serving as an astringent to the gums. The green pericarp of the ripe walnut is also used when available for this purpose, but it is more acidic and less suitable as a dentifrice.

The one disadvantage of this material as a dentifrice is that it is a dye which colours the mouth brown and for this reason it has fallen into disuse by the literate section of the Punjab communities. Some people do not like it on account of its astringency. These disadvantages are, however, more than counterbalanced by the

excellence of this substance as a mouth disinfectant and tooth preservative. In the opinion of the writer, of all the dentifrices at present on the market not excepting the very best, it would be difficult to find one to equal thoroughly shade-dried walnut bark in efficacy. It can be easily reduced to very fine powder and kept in air-tight bottles for daily use like any other tooth-powder. To make it very mild in action, it could be mixed with 25 per cent. of precipitated chalk before use.

IRRIGATED PLANTATIONS IN THE PUNJAB.

BY R. N. PARKER, I.F.S.

PART I.

Most Forest Officers have probably seen, from time to time, in the Annual Forest Administration Reports of the Punjab references to irrigated plantations now being formed or sanctioned. These plantations are intended to supply firewood and timber to replace the large areas of open scrub forest of semi-desert type which have been given up for cultivation in recent years. They are intended to be on the lines of the well-known plantation at Changa Manga except for one important difference. Changa Manga is situated at the tail of a big canal and was made to utilize waste water. Although the amount of water now given to Changa Manga has been considerably reduced in recent years, practically the whole of the water used in the plantation is still waste water as far as agriculture is concerned, and if the plantation were not there the water used would either not be admitted into the canal at its head or would escape back into the Ravi.

In the Punjab there are two crops known as the *rabi* and *kharif*. The rabi crop is the winter crop, mainly wheat, which is reaped towards the end of March or in April. The snow-fed rivers of the Punjab normally begin to rise towards the end of March, at which season the wheat crop is ripening and the demand for water from the canal begins to fall off rapidly. In the case of a canal like the Upper Bari Doab Canal, at the tail of which Changa Manga is situated, the whole discharge of the river is forced into

the canal during the cold weather and yet the canal is running only about half full and all the water is wanted for the wheat crop, the area of which is limited by the supply of water available from November to February when the river is at its lowest. Towards the end of March, however, owing to the rise of the river and the ripening of the wheat crop, surplus water is available and irrigation in Changa Manga usually starts. Somewhere about the end of March, irrigation usually ceases owing to the canal being closed for annual repairs to the head and main line, and water is not available again until about the 15th April. From now on to the middle of July there is usually more water in the river than the canal can carry, the cultivators are busy harvesting the wheat and consequently the demand on the canal is slack. This is the season when water is given to the plantation and irrigation goes on continuously. Towards the end of June the kharif crop begins to require more and more water, and by the end of July as a rule, unless there has been heavy rain, the canal is running full and the whole discharge is required by the cultivators.

It has been found by experience in Changa Manga that the plantation must be watered once between April and June. The amount of water required has been taken as 2½ ft. depth, and consequently the irrigation channels must be large enough to flood the whole area to a depth of 2½ ft. in 2½ months (15th April to 30th June). Actually there is a very large margin to allow for fluctuation in the supply of water and also to enable irrigation to be done quickly. The soil in Changa Manga having been under dense tree-growth for some 50 years has become very porous so that if a small supply of water is poured upon a big area, the area will never be flooded completely as a portion of it will soak up the water as rapidly as it is given and the rest will remain dry. Consequently in irrigating, as far as possible, the largest supply that can be dealt with is used on a small area, and, as soon as that area is flooded, the water is cut off and used elsewhere. The present irrigation channels can carry 88 cusecs per 1,000 acres. (1 cusec = 1 cubic foot per second.) If the canal could carry sufficient water to its lowest reaches, the whole plantation

could be flooded to a depth of $2\frac{1}{2}$ ft. in 14 days. These large irrigation channels mean that a sudden increase in the supply can be used and, if necessary, the irrigation of the plantation can be stopped entirely for a week or ten days, and the loss of time can be made good by increasing the supply when it is available. The plantation, therefore, serves as an additional escape to the canal, and has the advantage over an ordinary escape in that waste water is used for growing timber and firewood.

The new plantations have been designed to be flooded to a depth of 3 ft. in six months (April to September) and the irrigation channels have a discharge of $10\frac{1}{2}$ cusecs per 1,000 acres against 88 cusecs per 1,000 acres in Changa Manga. There is one exception to this and that is the Kot Lakhpat plantation in which the channel has been designed for 8 cusecs per 1,000 acres. Under these conditions, none of the new plantations can compare with Changa Manga as financially profitable undertakings, because the value of the water they use must be taken as its value for agriculture as also the value of the land they occupy. In Changa Manga the water used is practically valueless for agriculture, and consequently the value of the land occupied is its value as unirrigated waste land. The new plantations have been sanctioned to meet the demand for firewood and timber, and it is realized that they will reduce the amount of water available for agricultural crops. Most of the new plantations are situated on new canals, and on them, at present, the demand for water is not pressing, but it seems probable that the time will come when the irrigation arrangements will have to be altered so as to give more water in April, May and June and none in August and September. Such a change would be to the advantage both of the Irrigation Department and the Forest Department.

In Changa Manga, it has been found that the plantation must be watered once by the end of June or the trees begin to die off, and even the end of June is rather late in a dry year. A second watering in the year is not necessary, although it increases the growth; and if water were available at the right season, it would be much better to double the size of the plantation and irrigate

it once, rather than irrigate the whole twice in the year. In the new plantations, with a maximum discharge of 10½ cusecs per 1,000 acres, if one assumed that the channel started to flow on the 1st April (the 15th April would probably be nearer the actual date) and flowed continuously without varying, it would take up to the end of July to irrigate the area once, giving 2½ ft. depth. In practice, allowing for irrigation starting late and fluctuations in the supply it will probably not be possible to finish the irrigation till the end of August, and unless the monsoon is very early and good, any portions watered late in July and August will be badly damaged. Two or three years of late watering would kill the crop completely in Changa Manga.

Shortage of water, during the early part of the irrigation season, is already being felt in two of the new plantations; and as it is found that areas sown in the previous years require almost all the supply available, very little remains over for new sowings until the portion already sown has been watered, by which time the best sowing season has gone and the formation of the plantation is delayed as sowings cannot be done at the end of the irrigation season. The amount of water required in a young plantation for *each* watering is much less than in an old plantation. This is due to several causes. Firstly, in a young plantation the water need only be run into the trenches along which the seed was sown, so that only about 1-10th of area is actually under water; whereas, in an older plantation, the trenches become blocked by rats digging into the sides and throwing the earth from their burrows into the trench, and consequently to ensure the whole area being watered it is necessary to flood the surface. Secondly, as the trees grow up, the ground becomes more porous owing to the soil being opened up by the roots of the trees, and to the humus becoming mixed with the upper layer of soil. Almost all unirrigated soils in the Punjab contain a certain amount of alkali, the effect of which is to render the soil impervious to water. By planting trees and thus reducing surface evaporation, and by repeated irrigation the alkali gets washed out of the soil with the result that the amount of water the soil can absorb increases.

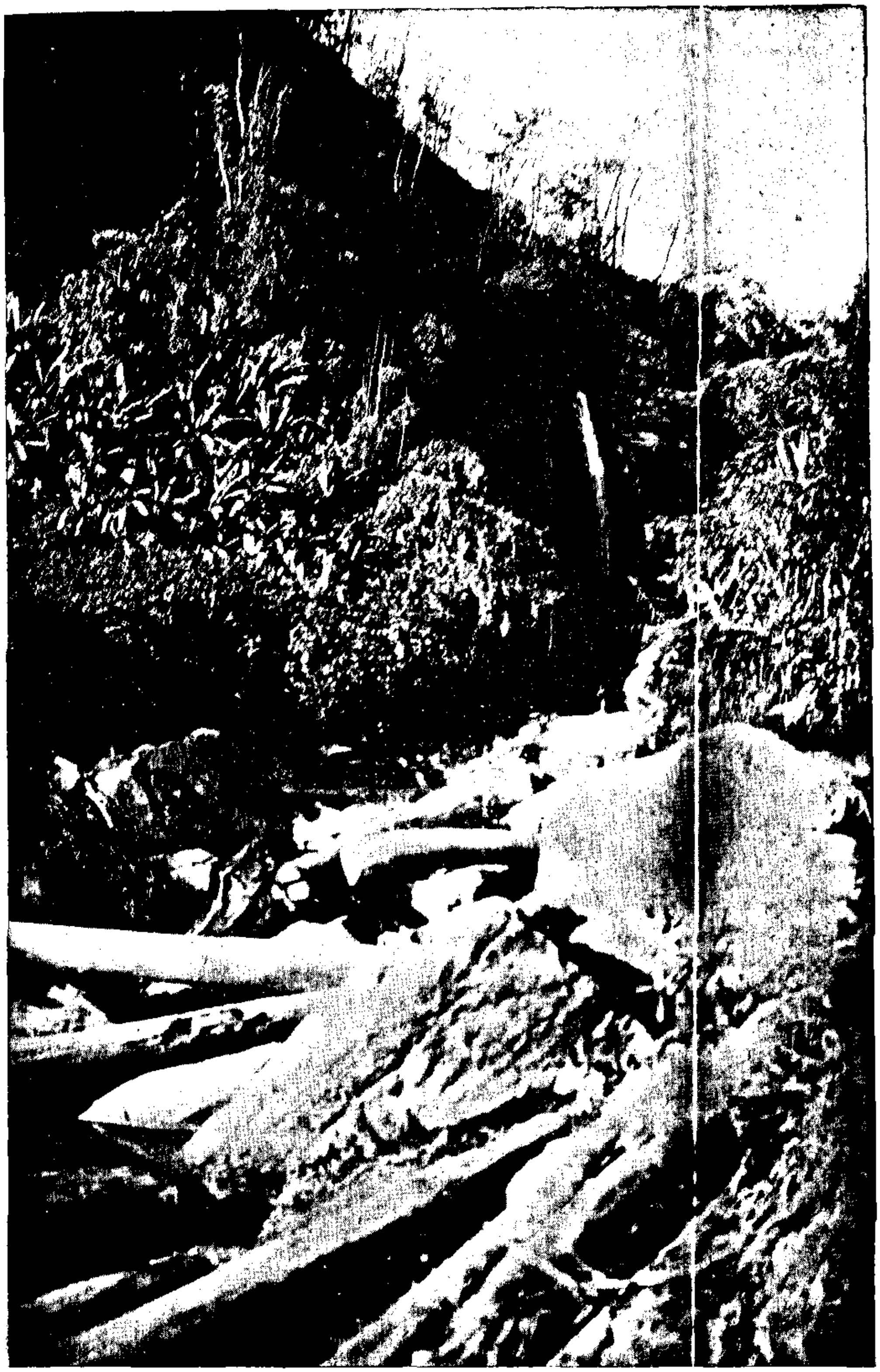
For these reasons the amount of water required to irrigate an acre of old plantation is much greater than the amount required for an acre of young plantation. As each area must be watered once before the end of June, the quantity of water used increases rapidly after the first few years, and hence there is a scarcity of water during the first part of the irrigation season which is the best time for sowing. Shortage of water during the sowing season has already caused delay in the Kot Lakhpat and Chichawatni plantations, and the schemes under which they are being made cannot be adhered to, as sufficient water for fresh sowings is not available until near the end of the irrigation season by which time it is too late to sow.

The following table gives the names and some particulars of the new plantations to which Changa Manga has been added for comparison :—

Name.	Area in acres.		Date of commencement.	Capacity of the irrigation channels in cusecs per 1,000 acres.
	Gross.	Nett.		
Changa Manga ...	9,605	9,191	1866	88
Kot Lakhpat ...	1,965	1,965	1911	8
Chichawatni ...	10,930	8,563	1913	10½
Khanewal ...	17,708	16,509	1917	10½
Tera	837	350	1917	...
Daphar	7,000(?)	?	1919(?)	10½

In addition to the above, the plantation at Pir Mahal may be mentioned. This plantation has existed on paper for over ten years, during which time the area decreased from 45,000 acres to about 15,000 acres. It has not yet been started, so that no further particulars can be given about it.

[*To be continued.*]



THE SINMAKADIN FALLS, PEGU DISTRICT, LOWER BURMA.

NOTE ON THE SINMAKADIN FALLS, PEGU DISTRICT, LOWER BURMA.

BY J. B. FRESSANGES.

This note is based on the extraction of about 3,500 logs from this stream, all of which had to pass over the falls. The compartments from which the logs were obtained were at the extreme head-waters of the Sinmakadin, numbered 96, 97, 98 and 99.

It occupied us about two years to clear the bulk of the logs, but it was during the second year that the damage to timber occurred. The years occupied in the extraction were the rains of 1911 and 1912. In the year 1910 we brought out only 74 logs from this area.

The total number of trees girdled in these four compartments was 1,555 from which we obtained 3,418 logs.

As mentioned before, in the first year's floating operations we extracted only 74 logs, and although they passed over the great falls there was no apparent damage of any serious nature done.

En passant it may be mentioned, beforehand, that the logs after going over the falls have to pass a very rocky and boulder-strewn bit of stream before falling into the main Thitpok, and after they have got into the Kun have again to negotiate the famous Kun Gorge. These two obstructions are in themselves a cause of damage which is usually allowed for.

In 1910 and the following years, we did a considerable amount of blasting, particularly in the rocky stretch below the falls in Sinmakadin, when we cleared all the larger boulders and sloped away a small waterfall. We attributed any slight damage that may have been noticed to these two obstructions and not to the main falls.

We started the 1911 season with a neap of 1,368 logs, of which 77 were already below the falls. To this we added, in the course of dragging operations, 1,442 logs. This made a total of 2,818 logs, which were handled in this stream. Of these, a total of 1,886 logs arrived eventually at the Sittang River.

It was this year that it was first noticed that the logs were considerably damaged, and I calculated that at least 40 per cent. of them had shattered ends, and that this damage could not be accounted for by the other two bad stretches of river mentioned before.

Early in the year, realizing the probability of timber being damaged by going over the falls, it was decided to try and stop the logs and pass them over the hills near the falls. Steps were, therefore, taken to do this, and we thought that we were helped towards this by a jam of about 300 logs which had been formed about $1\frac{1}{2}$ miles above the falls. Unfortunately, this jam was carried away by the first rises in the season, and the whole mass of logs together with large numbers which had come down from above went in this one rise over the falls. I calculated that about 600 logs must have been floated over the falls in this one rise.

The next step to take was to improvise a barrier; and, for this purpose, Pyingado trees were felled on opposite sides of the river, so as to interlace, and as the place selected was very narrow and supported by rocky banks, we thought we would succeed. But this barrier was swept away after sustaining the weight of about 500 to 600 logs, and one of the Pyingado trees was actually found about two miles away below the great falls.

All other attempts this year to stop the logs were fruitless, and further efforts were, therefore, abandoned.

The next year 1912 opened with a heap of about 1,000 logs. During the progress of work during the dry weather, I went over the ground, and thought that a good deal of the damage might be avoided by directing the logs over the falls, and in a series of experiments I found that logs which would, in a high flood, be likely to go over the falls near the left bank of the river, would strike on rocks at the bottom and suffer damage. Timber passed over the lip at all other points fell into the deep pool at the bottom, and escaped all damage. This pool has a depth of at least 35 feet, and a longitudinal diameter of, I should say, 60 to 80 feet. This last measurement was not taken by me.

As a result of these experiments, I constructed a barrier at considerable expense, with posts embedded in the solid rock, and supported by strong stays also with the ends embedded in the rock. The whole was tied together with cross beams of Pyingado bolted to the posts with iron bolts and nuts. This permitted the free passage of the water but would direct the logs in the direction required, *viz.*, towards the right bank of the river.

The result of the floating season of 1912 was very satisfactory. We brought out nearly 500 logs, none of which had suffered any unusual damage.

The result of the three years' work in this stream may be summed up as follows :—

1. It is more than useless trying to stop timber so as to drag it over the falls. If you succeed in your object at any one point, you will always have the probability of the next rise carrying the whole lot away.

2. Timber passed over the falls in small quantities, with a barrier at the lip of the falls to direct the logs towards the right bank, does not get damaged at all.

3. No other scheme seems to be workable. Consequently, it would be my aim, if I had girdlings in these forests to work out, to fell and drag only small quantities yearly, say a maximum of 500 logs.

NOTES FROM THE DEHRA DUN HERBARIUM.

II.

(*Continued from* "INDIAN FORESTER," XLIII, P. 410.)

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

1. Lala Gulab Rai, Divisional Forest Officer, has recently sent to Dehra Dun for identification specimens of *Rhynchodia Wallichii*, Benth., which he found growing in a swampy locality in the Pilibhit District of the United Provinces. In the Dehra herbarium we also have specimens of this plant from Haldwani in the United Provinces (Sartaj Bahadur No. 59) and others collected by

Mr. C. E. Parkinson in the Andamans. Hitherto this species appears to have been recorded only from Sikkim, Assam and Burma.

2. In the above plant Sir J. D. Hooker correctly describes the corolla lobes as overlapping to the right (F. B. I., III, 667) in the sense usually adopted by English botanists, *i.e.*, the observer looking at the flower from the outside finds the right-hand margin of each lobe uncovered (Hole's *Manual of Botany*, 1909, Plate X, Fig. 19). In the same volume of the Flora, however, Sir J. D. Hooker describes the corolla lobes of *Holarrhena* as overlapping to the left (l. c., p. 644). This appears to be an error. In all specimens of *H. antidysenterica*, Wall., seen by the writer the overlap is clearly to the right and this is correctly given in Bentham and Hooker's *Genera Plantarum*, II, p. 708. This error has subsequently passed from the F. B. I. into the majority of our local Indian floras.

STOCK MAPS.

In doing the field work for a working-plan in Burma, a great deal of attention is invariably given to enumeration of sample areas on which to base an estimate of the stock. Having got our estimate we usually disregard it entirely, and base the prescriptions of the working-plan entirely on area. In most forests in Burma, the character of the forest varies enormously. Differences of aspect, elevation and especially of soil account for forest of widely different types within quite a small area. Enumeration frequently gives an entirely wrong impression of the stock and is, moreover, of little real use in drawing up the plan. It is impossible to work all the different types of forest by one method, and it frequently happens in Burma that the forest produced by certain classes of soil is not sufficiently valuable for the more detailed working that may be proposed. I believe that the most essential part of any working-plan is the Stock Map. This should be made as accurate and as detailed as possible. If we are to base our working-plans on area, it is essential that we should know the area of the different types of forest we are to work. In the past this has been too often ignored. A general Stock Map showing roughly the prevailing class of forest

has been considered sufficient. Some attempt is now being made to introduce the Uniform system. This necessitates regeneration and the production of a uniform crop. With the enormous areas to be taken in hand, it is not at present advisable or possible to take in hand any but the most valuable areas; moreover, our regeneration must be based entirely on area. For this it is essential to know the area and distribution of the classes of forest to be treated. For future working-plans, I would recommend that the most important part of the field work should be considered the compilation of as accurate and detailed a Stock Map as possible. Enumeration need only be used for a rough estimate of the stock on typical areas to give some idea of the yield and stocking. Sooner than scatter sample plots or linear surveys all over the area it would be preferable to count out completely typical compartments or blocks of each type of forest and apply the results to the whole. This is best done after the compilation of the Stock Map. The Stock Map itself should endeavour to show every different type of forest and especially the different kinds of bamboos in each, as the species of bamboo is the best indication of the class of soil. It should show, as accurately as possible, small patches of each type of forest down to 5 acres in extent. With a Stock Map such as this, together with the Description of Compartments, the Working Plans Officer would be in a much better position to draw up a practical Working-Plan than if he had an accurate enumeration of the whole forest; moreover, the Divisional Forest Officer would be in a far better position to undertake the work if he could rely on the Stock Map, especially where he has to arrange for regeneration under the Uniform system. I am personally suffering from the drawbacks of an inaccurate Stock Map and speak with feeling.

NGADAUK.

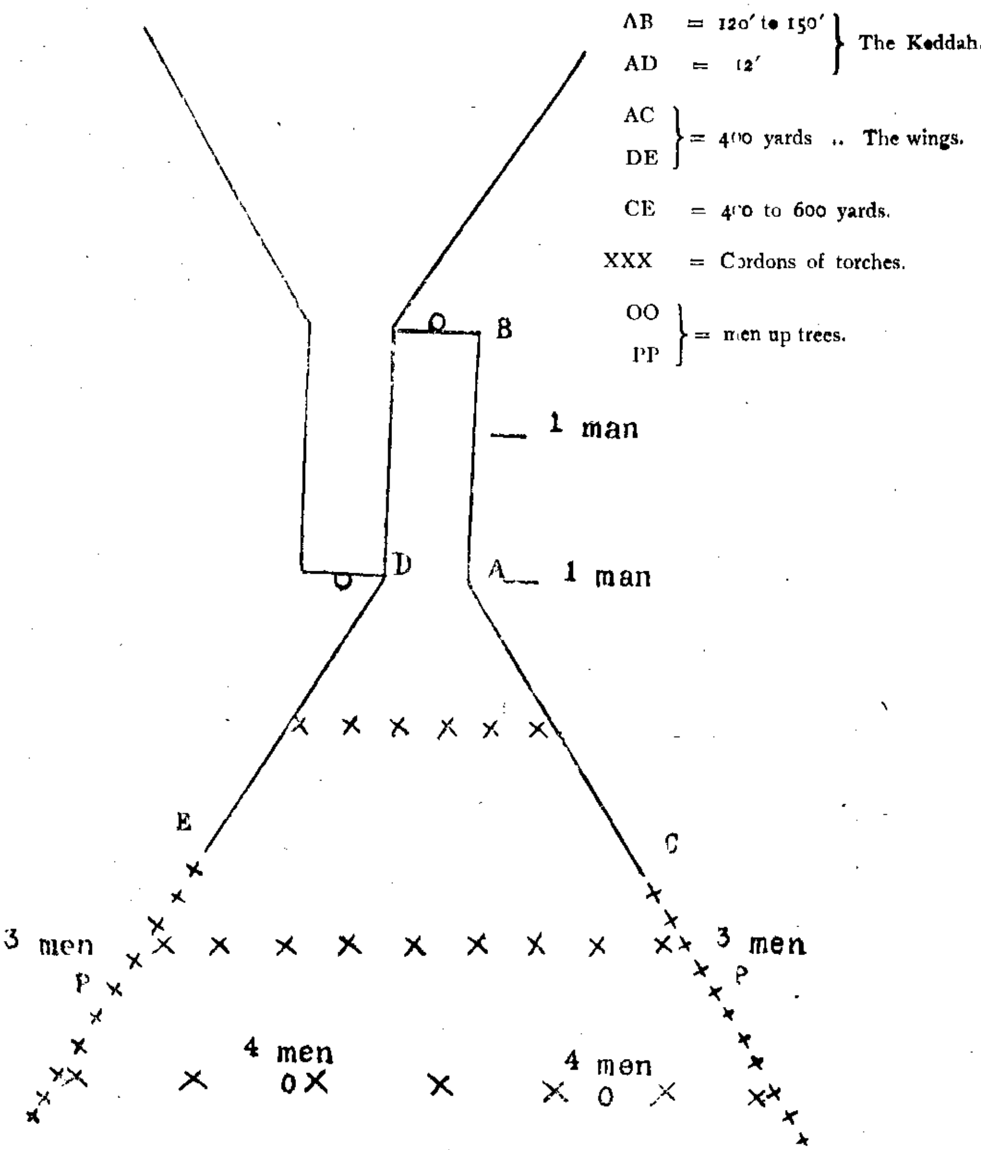
ELEPHANT CATCHING IN TENASSERIM.

BY J C HOPWOOD, I.F.S.

Although the capture of wild elephants in Burma by Government agency has been for some years in abeyance, and shows no signs of being revived, the industry is still being carried on in several districts by private enterprise, whilst in Tenasserim it is in a particularly flourishing condition; and having recently completed a tour of the Keddahs in the Kaleinaung Forest Reserve at the head-waters of the Tavoy river, it has occurred to me that a description of the methods here adopted and of the results obtained might prove of interest to readers of the *Indian Forester*.

Keddahs are erected in October, and the "Keddah year" is consequently taken from the 1st October to the 30th September next following, licenses being issued by the Deputy Commissioner with the concurrence of the Divisional Forest Officer. At present there are about a dozen licensees in the Tavoy district and six or seven in Mergui, and although the efforts of the majority meet with some measure of reward, by far the most successful are two Karen brothers, Mg. Ba La, who works the Kaleinaung Reserve, and Saya To, who operates in the drainage of the Little Tenasserim river in Mergui: further, not only as regards number of captures but also in the even more important matter of subsequent training and avoidance of loss, the Karens' methods seem to be very greatly superior to those of their Burman competitors.

The Kaleinaung Reserve is, for the most part, dense evergreen forest, through which the elephants have made well-defined tracks, and along these they descend during the cold and hot weather from the hill country along the Siamese frontier, to which they return in the rains; and the Keddahs are invariably erected on one of these well-known paths.



The above is a plan of a double Keddah, which has the advantage of taking elephants coming from either direction ; but is, of course, more expensive to construct, and takes more men to

work than does a single one: the Keddahs seen by me were, in all cases, single, with only one entrance.

The actual Keddah varies from 120 to 150 feet in length, and is about 12 to 15 feet wide at the mouth, tapering to 9 or 10 feet at the end, which is invariably built against a strong tree. The stockade consists of stout upright posts about 8 or 9 feet apart, and 12 to 15 feet high, to which smaller posts are firmly bound horizontally with cane; the structure is strengthened by means of buttress posts set at an angle of about 45° to the uprights, these being further connected at the top by cane ropes which are tightened by a tourniquet. The gate is an exact reproduction of the mediæval portcullis, and consists of a large number of sharpened stakes very firmly bound to a framework of small logs, and suspended from a stout beam by means of a rope of *shaw* (*Sterculia*) fibre; when the elephants have entered the Keddah, this is severed by the man posted over the gate, which falls by its own weight. Some Keddahs have a second gate in the middle, for the purpose of isolating, if possible, any particularly truculent animal. An ingenious detail is a bamboo suspended in the middle of the entrance, against which each elephant that enters necessarily brushes; as it swings back, it knocks against a beam, and enables the gate-man to count the number of elephants that have entered, a necessary precaution as the operations are carried out in pitch darkness. Finally, the interior of the Keddah is decorated with wild palm fronds, branches, etc., so as to resemble the natural jungle as much as possible.

From each side of the mouth of the Keddah a wing is built for a distance of 300 to 400 yards; this is similar in construction to the sides of the Keddah, but much less strongly built; it is intended to act merely as a stop to keep the elephants in the desired direction. The wings are about 400 to 600 yards apart at their termination, and are thence continued, for several hundred yards, by a line of torches placed in readiness upon posts; there are also two or three cross cordons of torches. These are made of the oil of the Kanyin (*Dipterocarpus vestitus*) mixed with decayed wood, and rammed into a bamboo; they burn well and give a good light.

The minimum number of men necessary is 16, posted as shown in the diagram ; but if available 30 or 40 can be employed with advantage. Driving is not resorted to, the men going out at about 5 P. M. and sitting up the whole night on 'machans' built at least 30 feet from the ground ; absolute silence is essential, and smoking and even the chewing of betel is prohibited. When a herd enters the cordon, the men at OO remain silent until the herd has passed the men at PP : as soon as the herd has passed them, the men at PP descend, light their cordon of torches and start shouting, whereupon the OO men immediately light their cordon and join in the uproar. I am told that if the OO begin the racket, the herd is too far from the Keddah, and likely to break out to the sides.

Directly the gate is dropped, the roping of the captives commences, and is accomplished first by passing noosed ropes into the Keddah with hooked and forked stakes and getting them on to the animals' legs, the rest of the rope being made fast to the nearest tree outside ; the men then get the neck rope on and, as far as I could ascertain, go into the Keddah to do so ; when this has been done, the animal is secured. A large male, however, frequently breaks away, smashing ropes, Keddah and everything he meets with, and there is little doubt that these Keddahs are not really quite strong enough.

Immediately after a capture, the tame elephants are sent for (there are not enough of these to keep a staff permanently at each Keddah), the captives consequently remaining tied up in the Keddah from 1 to 3 days, during which time they are provided with food and water, some of which is usually consumed. I was fortunate enough to arrive at one Keddah in time to see the four animals which had been caught taken out, which is done by attaching the captive firmly by its neck ropes to the tame elephant, which then hauls it out much as if it were a log. In the case that I myself saw, the wild elephants were all small ones, much smaller than the tame ones, so no difficulty was experienced : they simply *had* to follow : in the case of a large and troublesome beast, the ropes on the hind legs are paid out from trees, so that a pull on

the wild elephant is obtainable both fore or aft; in no case is the wild one ever placed *between two* tame ones ; it is always lugged out *behind* a single animal.

Having left the Keddah, each elephant is placed in a training cage, which is a miniature Keddah holding one animal only, and built in various sizes to accommodate large or small animals. The captive is firmly roped by the neck and legs, and in addition two cross bars are placed under the belly, and one under the neck : the whole arrangement is extremely ingenious and is designed to avoid straining, and once the elephant is secured, straining is quite impossible. The animal is kept in this cage about four days and is provided with as much food and water as it desires ; three men are attached to it for training, and one or other of them is almost continually on its head or back talking to it and accustoming it to being handled. Except with an unusually unruly beast, four days in the cage is sufficient, and the elephant is then taken out by a tame animal, and tied up with four or five ropes to trees, in a locality where it can feed itself on the neighbouring bamboo, food also being cut if necessary. This process goes on for about three weeks, the number of tethering ropes being gradually reduced, and at the end of this period the elephants are sufficiently tame to be turned loose to graze, fetters at first being placed round the thighs as well as round the fore legs, though the thigh fetters are soon dispensed with. It will thus be seen that an elephant is practically tamed within a month from the date of capture, and during the whole process the only weapon used is a blunt nail driven into the end of a stake, with which the elephant is prodded if inclined to be obstreperous : I saw these in use, and never saw blood drawn. The *shaw* ropes used for tying are rather on the hard side, and rough, and some animals are rather badly rope-galled ; the sores thus caused are carefully tended and quickly heal : in fact, cruelty appears to be reduced to the minimum in the Keddahs worked by Mg. Ba La, though I have reason to believe that the methods of some others are less humane.

On February 17th, I measured 13 elephants which had been caught on October 17th last, and had consequently been in training

exactly four months; two of these were a bit nervous, the others were all as tame as kittens, including two or three young tuskers: all were in A-1 condition, and the only wounds I could see were a few perfectly healed rope galls, and some slight cuts made with a spear on the forehead of one young tusker which is inclined to be playful and to butt people.

The Keddahs are run on the co-operative principle, and although it is a little difficult to get meticulously exact information as to the system adopted, it would appear that the money for each Keddah is put up by a syndicate of shareholders, each share being Rs. 200: a man who actually works at the catching gets a Rs. 200 share for Rs. 100. It appears to cost Rs. 3,000 to Rs. 5,000 to run a Keddah for the season, the actual construction costing some Rs. 500 or Rs. 600: it is no doubt this cost which prevents better and stronger Keddahs from being made, and I think there would be a saving in the long run if semi-permanent Keddahs were made of durable timbers, instead of their being made of the nearest available species, and lasting for one season only. Also, a big male elephant is worth several small females, and, as noted above, these large males frequently escape.

Returning to the syndicate, the catch is divided amongst the shareholders, apparently after the elephants have been tamed: losses from death usually occur immediately after capture, and are jointly borne by all shareholders. An elephant, therefore, may finally pass into the possession of several persons who divide the proceeds between them when the animal is sold. For purposes of dividing the spoils, the elephants are valued, and distributed accordingly: any disputes are settled by Mg. Ba La, and one and all express the greatest confidence in his fair dealing: so far as I know, his decision is, in all cases, accepted as final. He obtains the licenses from Government, pays all royalties (Rs. 50 per elephant irrespective of size), and generally runs the whole show; his share is one elephant in every ten, and he is entitled to take his pick, and, as far as one can gather, he exercises this option with a most praiseworthy moderation, and does not take the cream of the catch, though fully entitled to do so.

The season so far has been a bad one, which the Keddah operatives attribute to the six Survey of India parties who are this year working in the reserve ; up to date six Keddahs have captured 29 elephants, and of these five have died ; one small animal was mauled by a tiger whilst tied up, two died of injuries received in the Keddah, and two refused food after capture. Against these, however, must be set the capture of a magnificent "hine" (tuskless male) which I saw in the training cage, and which is reported to be doing well ; he is a young animal, measuring 8′ 4″ with a girth of 12′ 6,″ beautifully shaped, and worth fully Rs. 7,000 when trained. It is of interest to note that this animal, who is easily recognized by his stump tail, has twice before been in a Keddah, and broke loose on both occasions. A Keddah, run by Burmans, which I have not yet visited, is reported to have had nine deaths out of a catch of 13 ; and the comparison of this with Mg. Ba La's Keddahs indicates that there is something radically wrong with the methods adopted. Normally I do not think that the mortality under Karen methods should, or does exceed 10 per cent.

Below will be found a statement of the captures since 1909 : the figures for 1916 and 1917 are exact ; previous figures, though very approximate, may possibly contain errors :—

Year.	Tavoy.			Mergui.		
	Licensees.	Captures.	Deaths.	Licensees.	Captures.	Deaths.
1909	...	5	5	...	...	...
1910	...	16	3	...	...	...
1911	...	...	...	...	..	...
1912	...	...	...	...	..	...
1913	...	24	18	...	...	...
1914	...	18	2	...	...	...
1915	7	77	29	5	19	..
1916	8	133	...	6	99	...
1917	11	180	...	7	100	...

In conclusion, I may mention that the license provides that the elephants are to be produced for measurement before an officer appointed by the Deputy Commissioner within three months of capture: and that within 20 days of such measurement, Government has the right to buy in any animal not exceeding 6′ 6″ in height at a fixed price of Rs. 800. Up to date this option has not been exercised.

SHIKAR EXPERIENCES.

BY P. DOBSON, BENGAL TIMBER TRADING CO., LD.

The following three incidents are, I believe, rather uncommon, and not being every-day occurrences may be of interest. All, with the exception of the third, occurred in the Singhbhum district. This took place in the Bonai State but within a quarter of a mile of the Singhbhum boundary and, I believe, the tigress on this occasion came from over the boundary.

When in camp at a village called Ponga and about 2-30 P. M., a cooly who had just come in from another village informed me he had seen a dead tiger lying alongside one of the Forest Department's fair-weather roads about 3 miles off. He could give me no particulars as he said he was alone and had given it a rather wide berth. Being interested in what he reported, I took my rifle and a chaprassie and went out. When nearing the place where I had been told the dead tiger was lying, I heard something make off into the jungle; I asked the chaprassie what he thought it was, he said he thought it was a pea-fowl. I could see nothing so went on, and on going about 40 yards from where I had pulled up on hearing something making off, I came on an absolutely fresh track of a tiger, and I have now no doubt but that what I heard was a tiger moving off and not a pea-fowl. The chaprassie now agrees that it *must* have been a tiger. I am not at all certain whether the track was that of a tiger or a tigress; it was a large pug mark, but being on a very dusty road might have

been the track of a large tigress, the foot leaving a much larger impression in the dust than would have been the case had it been on harder ground. On going a few yards further, we came on the dead tigress barely cold, lying just at the side of the road; I examined the body and found it bore the marks of three canine teeth in the back of the neck and of two canine teeth in the off-fore shoulder, and the off-fore leg was broken. As I thought it possible the other tiger might return for a feed, I sent my chaprassie back to my camp with instructions to return about dusk with four coolies and some rope; it was then about 4 P. M., so I sat quietly behind a tree till the return of the chaprassie, hoping the tiger might, in the meantime, return but he failed to do so. On the arrival of the chaprassie with the coolies we tied up the dead tigress and carried her into camp. Being the cold weather and knowing she had not been dead very long, I left the skinning till the following morning, which my bearer commenced very early. On removing the skin and on looking at it from the flesh side, it was found to be simply covered with claw marks, the skin was not torn in a single place, the only marks on it being the five holes inflicted by the canine teeth and the discoloured flesh showing up the marks of the claws. The dead tigress taped, when measured, between pegs 8′ 2½″. It was unfortunate I was not able to get the other tiger, there would then have been no doubt left as to its sex; but, I believe, it must have been a tigress as it would be against all animal instinct for a male to attack a female and the dust on the road, I feel sure, would make the impression of the foot larger than it should have been.

When in camp at Tholkabad, I shot a Bison. As soon as the news reached the village all the villagers came out for the meat, and not until one of the Hos drew my attention to the fact did I notice I had shot a castrated Bison! My first thought was that this animal had, at some time, been the victim of an attack by wild dogs but, on examination, showed at once that this was not the case; there was a distinct scar down the scrotum showing the operation had been a very clean one. The conclusion at which I arrived was that this Bison when very young must have been

caught by some one, who had castrated him with the object of taming him, the Bison some time later escaping or having become too much of a handful was turned out. The sweep of the horns round the curve taped $74\frac{1}{2}''$ and each horn at the base had a girth of $17\frac{3}{4}''$; he was a middle-aged animal and the height at the shoulder was just 16 hands; whereas the three other Bisons shot by me all measured 18 hands or just over. I need hardly add that this Bison was a solitary one. As the Hos' version of how he came to be minus a most important part of his anatomy may be of interest, the following is what they will have as being correct:—The Bison was the property of a Bonga,* who drove him as one of a pair in a cart; the Bonga had performed the operation and they were very keen on my looking for his pair, which they said must be somewhere near by; they assured me that if I shot the other, I would find him to be in exactly the same condition; needless to say, I did not look for the pair.

A tigress had for some time done a great deal of damage among our carters' cattle, killing three and four bullocks a week. Once when in camp near her beat, and having received information that she had killed a bullock, I went out about 1 P.M. and by 3 P.M. had got into a 'machan' which I had had erected on reaching the kill. The tigress had eaten practically nothing, and about 5 P.M. I saw her returning for a feed; she stopped when about 60 yards off and there appeared to be a whole pack of tigers. Seeing there were so many, I decided to let them come on, which the tigress did after a few seconds. I allowed her to come up to the kill, then shot her in the neck; she dropped to the shot without a sound; the cubs, as the others turned out to be, bolted a few yards and then wandering round and round my 'machan' gave me easy shots. I dropped three cubs, but the fourth by this time had got really frightened and had bolted some little distance. As he did not return and thinking it possible he might have lost his whereabouts, I got down from the 'machan' and went after him, but unfortunately he saw me before I saw him, stopped calling and bolted. I got in a shot and hit him, but he made good his escape,

* *Note.*—Bonga means a god.—H.H.H.

for although we followed up the blood we never saw him again. I have related the above as I believe it is rather unusual for a tigress to give birth to four cubs, and still more unusual for a tigress to have brought up *all four*. The tigress measured between pegs $8' \, 4\frac{1}{4}''$ and the cubs also measured between pegs $5' \, 2\frac{1}{2}''$, $5' \, 1\frac{1}{4}''$ and $5' \, 1\frac{1}{4}''$: all three cubs were males, and I wish I had been fortunate enough to get the fourth if only to see if it were also a male.

[*Note.*—Cases of four tiger cubs are not very unusual. Four cubs, two of each sex, measuring from $6' \, 9''$ to $7' \, 2''$ in length, were shot in my presence near Ramnagar, U. P., in April 1908. Also in same locality in March 1909 I myself shot a tigress containing six unborn cubs, three of each sex.—HON. ED.]

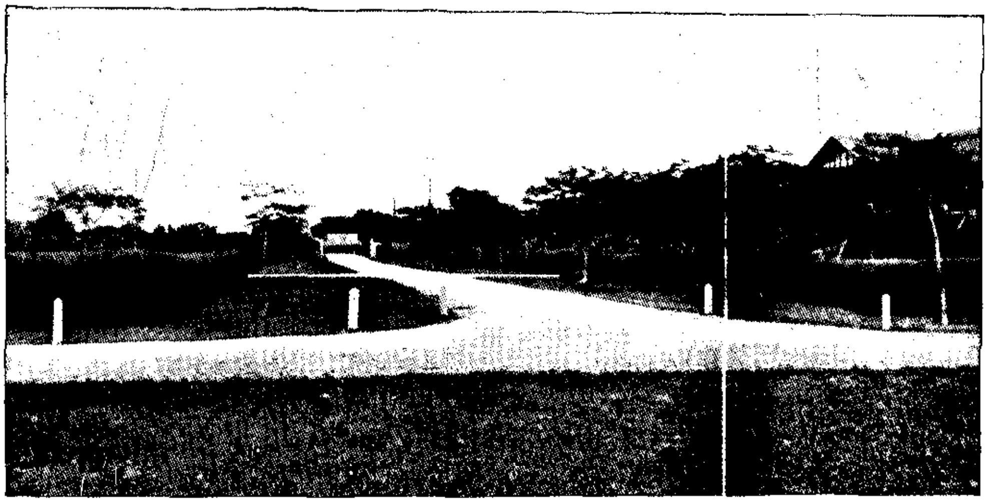
EXTRACTS.

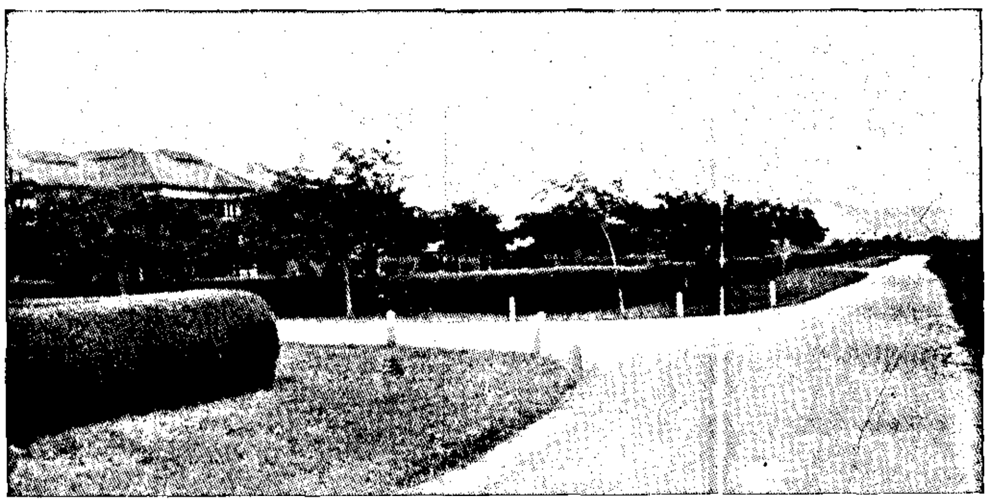
ACACIA MODESTA, A HEDGE PLANT.

The photographs reproduced (Plate 25) may be of interest to those who are trying to grow hedges or testing plants with that object in India. The plant is *Acacia modesta*, not indigenous to Burma, but, I think, to the greater part of North-Western India. It produces a very thick, impenetrable hedge in a short time and is here (Mandalay) far superior to any of the other plants, *e.g.*, *Inga dulcis*, *Acacia arabica*, *Duranta*, etc., that have been tried.

Acacia modesta if properly treated does not, like *Inga dulcis* and some other plants, grow tall and form a top without any thickness below. It is impenetrable to the ground and at two years old the hedge shown in the photographs was quite impassable even for a hare. Moreover, this plant does not require so much cutting as some others, like *Acacia arabica*, which send out strong shoots so freely that it is difficult to keep them within bounds without continual clipping. Two (or at most three) clippings are given annually to the hedges shown. The spines of *A. modesta* are plentiful but not so long as those of *Acacia arabica*.

This hedge is growing on a stiff, impervious clay where trees and few plants can be grown without the greatest difficulty, yet at a two and half years old it was about 4 feet high, the desired height, and so thick that no stock, not even a buffalo, would try to pass through it. It has since gradually thickened and at seven years old is still thriving, and to all appearances will continue for several years more before it needs cutting down. It withstands the extreme dry weather, except when very young (the first year) without water though it loses some of its leaves at that time if not watered. Even then owing to the free branching it is not possible to see through the hedge.





Typical Hedges of *Acacia modesta.*

(Reproduced by kind permission of the Agricultural Adviser to the Govt. of India, Agricultural Research Institute, Pusa).

We have so far been able to grow it from seed only—cuttings do not "take." The seed should be sown as soon after it is ripe as possible, *i. e.*, about September—October.

On this water-logged soil we sow on a slight ridge in a single line about one seed to the inch and cover with ½ to 1 inch of soil. On more genial soil less trouble should be required. If rains are unfavourable, watering is necessary till the following monsoon. Judicious clipping, when the plants are young, will induce free branching and easily give density below. The hedge should of course be allowed to attain the required height and thickness by slow degrees—each clipping permitting it to grow a little larger. If this is not carefully attended to, density is lost. If cut down almost to the ground, *Acacia modesta* will shoot again freely, so that it should not be difficult to renovate an old hedge.

When clipped into the form of a hedge the plant seldom produces any seed and the supply of this for further sowing is a great difficulty here, for there is a lively demand which we are entirely unable to meet. Seed obtained from the Punjab did not germinate—partly because it was badly damaged by larvæ of some insect, but largely, we believe, because it was old and had lost its vitality. We shall, therefore, be greatly obliged if any reader of these lines in India can help us in obtaining fresh seed.

This plant, the merits of which were discovered by accident, is strongly commended to the notice of those who wish to grow useful and at the same time ornamental hedges.—E. THOMPSTONE.—[*Reprinted from the Agricultural Journal of India, Vol. XIII, Part II.*]

CONTROLLING DRY ROT IN TIMBER.

In a paper recently read before the Institution of Municipal and County Engineers (London), Mr. E. J. Goodacre, in discussing the question of dry rot in timber, remarked that in dealing with cases where the presence of a serious attack of dry rot had been established, drastic action was necessary. The infected wood should, he said, be oiled to keep down the spores, and carefully removed and burned, and not deposited in a builder's yard. The

carpenters' tools, especially the saw, used on the work should be sterilized. This might, he said, appear to some to be rather too stringent, but the advisability of such a precaution was undoubted. The adjoining woodwork should be carefully tested and removed if there were the least signs of the fungi. The brickwork or stonework should be sterilized by a blast flame, and the woodwork should be dried—not by a gas jet which formed moisture as a product of combustion—and treated with a wash of dilute formalin which is a safe and most effective antiseptic, although it must be noted that through evaporation this treatment is purely temporary. Carbolic acid is also a valuable antiseptic for the purpose. Hot limewash is very useful for a mild attack, and, in fact, most antiseptics are more or less effective. In conclusion, Mr. Goodacre strongly urged that owing to the difficulty of completely eradicating the fungi when once established, preventive measures were of paramount importance.—[*Scientific American Supplement.*]

BALSA WOOD.

In reference to the paragraph headed "Balsa Wood" in our issue of January 12th last (page 73), in which we ask for further information regarding this wood, we have received from the Imperial Institute of the United Kindom, the Colonies, and India, South Kensington, the following statement, which will be interesting to our readers :—

Balsa wood, also known as "West Indian corkwood," and "bois flôt," is derived from *Ochroma Lagopus*, a well-known tree occurring in the West Indies and tropical America, and belonging to the natural order *Malvacea* (Mallow family). Most of the names applied to the wood have reference to its lightness, "Balsa" itself being a local name for a type of raft used in certain parts of South America. The natives also use the wood for making floats for fishing nets. The tree is stated to reach a height varying from 30 to 70 ft., with a diameter of from 1 to 2 ft. It is known in Jamaica as the "Down Tree," in reference to the pale-brown

silky floss enveloping the seeds in the long, narrow pods. This material resembles kapok, and is used locally for stuffing cushions, etc.

Samples of Balsa wood were received at the Imperial Institute from British Honduras in 1912, for examination and report. The wood is white (sometimes stained red) and lustrous. It is soft, spongy and very light, Grosourdy quoting the specific gravity as 0·120. The wood is stated to have been employed in the manufacture of life-belts, as a cork substitute for bottle stoppers, and for fenders for life-boats. Owing to its tastelessness and the absence of injurious properties, its use as a material for cigarette tips in place of cork has been suggested. Experiments have been made as to its suitability, when in the form of woodmeal, as a material for increasing the sensitiveness of blasting explosives, but the results were not very satisfactory. Tests made as to its insulating properties indicate that the wood may have value as an insulating material. It is also stated to afford good chemical wood pulp for paper-making. Owing to its spongy and fibrous character, the wood is difficult to work with tools.

In a recent Commerce Report of the United States it was announced that "millions of feet" of Balsa wood could be shipped from Panama for export to the States, and that a reliable firm in the Province of Bocas del Toro has asked to be put in touch with possible purchases.

Samples of Balsa wood may be inspected at the Imperial Institute on any week-day between 10 A.M. and 5 P.M. (Saturdays 1 P.M.), and a limited number of small samples is available for distribution to enquirers specially interested. Visitors to the Imperial Institute should inquire for the Technical Information Bureau.

A piece of the wood submitted to us measuring $5\frac{3}{8}$ in. $\times$ $2\frac{3}{4}$ in. $\times$ $1\frac{1}{8}$ in. weighs a little over $1\frac{3}{4}$ oz.—[*Timber Trades Journal.*]

[*Note.*—This works out at about $11\frac{1}{2}$ lbs. per cubic foot.—HON. ED.]

GETTING RID OF TREE STUMPS.

The *Quarterly Journal of Forestry* recently discussed the question of how to get rid of tree stumps by a less expensive method than grubbing. In the course of an article on the subject, the editor of this well-known publication gave an account of a method which he, personally, applied in killing about a dozen poplars, some 20 feet high, and having a stem diameter at the base of six or eight inches.

"The design," he says, "was to kill the trees as they stood and to utilize the dead stems still standing in their original position for the training of creepers over them. In the early part of the summer a hole, slanting somewhat downwards, was bored with an inch auger near the ground, the hole reaching nearly through the stem. Oil of vitriol, that is, crude sulphuric acid, was then poured into the holes by means of a pipette. In a few days the acid had been absorbed and the holes were again replenished. In a short time the trees died, and so effectively were the roots killed that there has been no production whatsoever of sprouts."—[*The Australian Forestry Journal.*]

FOREST AND RAINFALL.

The recent conference in Melbourne called forth a valuable paper on the influence of forests on rainfall. Its value was in its scientific observations and accurately recorded data. To the lay mind it might have unfortunate results, as the conclusion arrived at was that forests exert little, if any, influence upon rain precipitation.

To bring the forces of cold scientific facts to explode the popular fallacy that trees attract the clouds and cause rain, would be a misfortune, and one of the dangers of a little knowledge. For a popular battle-cry for Forest Leaguers, none could be better in this country than "Forests bring the rain." Although not strictly in accordance with experiment, the results are much the same. Mr. Griffith Taylor is of opinion that there has been some confusion of cause and effect in the historic association of

forests and rainfall, and from conclusive records he finds that the rain is the cause and the forest the effect. The popular idea is rather the other way round. Better half a truth than none at all, perhaps, and, at any rate, the association of the two is correct beyond all doubt. Forests do not cause the precipitation of the rain, but they do function most importantly in conserving the water that falls on the earth's surface. A treeless desert may have the same annual rainfall as virgin forest. In the former is the erosive force of the waters escaping unimpeded to the sea, disintegrating and levelling by flood and fury the already barren land. In the latter, the forest lands conserve the rain in the watersheds; and release it gently and beneficially to the coast by fertile channels.

If our legislative head-quarters staff had a full realization of the "fly wheel" effect of our forests on the rainfall, they would lend a readier ear to our advocacy.—W. RUSSELL GRIMWADE, in the *Gum Tree*.—[*Reprinted from the Australian Forestry Journal.*]

DWARF ELEPHANTS.

A NEW AFRICAN SPECIES.

[FROM A CORRESPONDENT.]

There have recently arrived in England evidences of the most important zoological discovery that has come to light since the finding of that strange beast, the Okapi, in the Congo forest some years back. This discovery proves very completely the existence of a new and hitherto unknown species of elephant, a real dwarf elephant, which in adult specimens attains no greater height than about 5ft. 6in. to 6ft., or about half the height at the shoulder of the ordinary African elephant.

Two complete specimens, male and female, have reached Messrs. Rowland Ward (Limited), the taxidermists and naturalists, of 167, Piccadilly. These extraordinary elephants were shot in the Congo country by Mr. J. Rowland Evans; one complete specimen is to be offered to the Natural History Museum, at

South Kensington, by the generosity of Mr. R. L. Scott, a well-known East African and Rhodesian big game sportsman. The destination of the other is at present undetermined. Opportunity has been given of examining carefully the evidences of this new and remarkable discovery, which include not only the complete skins of the two dwarf elephants, but the bones, skulls, and tusks of the animals. Both are evidently full-grown beasts, the molars being much worn from many years of use. The legs, ears, and tails are of distinctive character, and there can, one believes, be no doubt that the specimens of this invaluable zoological find are destined to be classed by scientific naturalists as a completely new species of elephant.

There have been rumours for some years past of an African dwarf elephant, but hitherto no real evidences of the fact have reached this country. The tusks of the two animals, which are very dark and show strong signs of wear and tear and of exposure to a moist or muddy habitat, are extraordinarily small. Those of the female weigh no more than 2lb. the pair, while the tusks of the male reach 7lb. the pair. The tusks of a well-grown African bull elephant from the region of the great central lakes often attain as much as 110lb. apiece or 220lb. the pair, while in particularly fine examples a single tusk has been known to scale the enormous weight of 180lb. It will be seen, therefore, how puny are the tusks of the new dwarf elephant.

By the natives of the region from which these very interesting mammals have been received this dwarf species is known as the "swimming" or "water" elephant, pretty conclusive testimony that these animals, as their discoloured tusks show are found in a watery habitat. A few years ago much interest was evinced in the accounts brought to Europe of a "Bamboo" dwarf elephant, shot in the Rukiga district of the Eastern Congo by Dr. C. H Marshall, of the Anglo-Belgian Boundary Commission; but this was apparently a considerably bigger race, the measurement at the shoulder of an adult female reaching 8ft. 9in., while the tusks scaled respectively 12lb. and 15lb. apiece. It would seem, therefore, that the new specimens received by Messrs. Rowland Ward

are the real pigmies among African elephants, while the "Bamboo" race occupies a position midway between the pigmy and the big species. From Africa, as Pliny long since remarked, there is always something new, and this latest discovery should prove of remarkable interest to all naturalists and sportsmen.--[*The Times.*]

WHITE ELEPHANT CALF.

A Burman correspondent informs us that on the early morning of 5th instant a female elephant named Mee Khin belonging to Messrs. the Bombay Burma Trading Corporation, Limited, gave birth to a white female calf in the Yezin forest of the Pyinmana division. This calf, he says, unlike others of her sex, possesses a pure silvery white skin and body, with pearl eyes. According to Sinoke's (Head Mahout) statement this wonderful calf seems to have all the necessary qualities of a proper Sinbyudaw (Honourable White Elephant). Hundreds of villagers and townsfolk are now daily visiting her rest camp on the bank of the Paunglaung. Rumours concerning her have run so far that on her entry to a village, the rejoicing villagers come out to a respectful distance to meet her with music.—[*Rangoon Gazette.*]

A NURSING HOME OF WHITE ELEPHANTS

To THE EDITOR, "RANGOON GAZETTE."

SIR,—Yesin forest, where a white elephant is supposed to have been born, must be recognized as a nursing home of the Sinbyudaws, for it is not the first time that it honours the country with a Sinbyudaw, if the present one is real. During the reign of our last king one white elephant calf was found roaming about the forest surrounded by a large number of wild elephants—a distinctive feature of the majestic influence of a real white elephant, which must also be observed in the present one. That white elephant was caught by the Burmese authorities, and nursed by fifty strong and healthy nurses and made to drink from bowls of precious metals. Then, as I have been told by an old friend

of mine who belonged to the party of those who were commissioned to catch the white elephant, it was taken to Mandalay on a litter carried by men, together with fifty nursing women, but unfortunately the young elephant died *en route* to Mandalay. There is a hill on the east bank of the Paunglaung river in the Yezin forest which is called Sinbyudaung (white elephant hill) in which there is also a cave called Sinbyudwin (white elephant cave). The deep grey of the hill which combines with the thousand hues of the bright sunshine reflecting from the silvery waters of the quiet river creates a glowing landscape palpitating with life and beauty, a place than which a more suiting home for the white elephant could not be found.

Yours, etc.,
MAUNG KYAW,
Late of the *Sun*.

No. 7, 37th Street, Rangoon :
1st *April*.

[*Rangoon Gazette.*]

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A NOTE ON THE ECONOMIC VALUE OF THE CHINESE TALLOW TREE (*SAPIUM SEBIFERUM*).

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

Introductory.

From the literature* on the subject of the Chinese tallow tree, it is evident that the idea of extending its cultivation in various localities in India, where it began thriving well, especially in the United Provinces and the Punjab, was given up, simply because the preliminary experiments on the extraction of fat and oil from the seeds indicated that the labour and expense involved in collecting seeds and extracting the tallow were far in excess of the value of the products. This has been rather unfortunate in view of the fact that in China the tree

* See *Agricultural Ledger* No. 2, 1904, which gives its habitat, introduction in India, the composition of the fats and the processes of its preparation from the seeds and an account of the experiments done in India to prepare the fat with negative results. See also Watt's *Commercial Products of India*. See also "Chemical Technology and Analysis of oils, fats and waxes" by Lewkowitsch, Vol. II, p. 70 and pp. 483–489.

is a source of some remunerative trade in Chinese tallow. It seemed to the writer that the preliminary experiments carried out in India, which have been quoted in different places, were not carried out properly and owing to the bad results obtained, the cultivation in India of a useful tree was wrongly given up. This note embodies the results obtained by the writer, which indicate that the question of the experimental cultivation of this tree is well worth reconsideration.

The yield of solid tallow.

The fruits when dry open up and the white seeds can be easily beaten out by means of a wooden mallet. It was found that 20 green fruits weighed 30·795 grams, and the green upper covers amounted to 18·535 grams, the white seeds being 12·26 grams only; 100 grams of the white seeds when extracted with ether in a Soxlet's Extraction Apparatus to remove all the white solid fat embedded in the upper white coating of the seed, gave 23·31 per cent. of fat. 100 grams of crushed seeds which had their inner kernels containing a drying oil all exposed to the action of the solvent gave, by ether, 43·51 per cent composed of fat and oil. The oil in the kernels, which is an excellent drying oil similar to linseed oil, for paints and varnishes, thus amounted to 20·20 per cent. Another lot of 3,000 grams of the uncrushed white seeds was extracted in the small extraction plant with petroleum benzine and 729 grams of the fat was obtained, the yield being 24·30 per cent.

The Chinese process of preparing the tallow as given by Dr. Porter* Smith is as follows:—

The Chinese processes of the manufacture of tallow and oil.

"The ripe nuts collected in mid-winter are bruised and the *pericarp or shell separated by sifting*. They are then steamed in wooden cylinders with numerous holes at the bottom which fit upon kettles or boilers. The tallow is softened by this process and is separated from the albumen of the seeds by gently beating them with stone mallets when the tallow is effectually removed by sifting the mass with hot sieves. The tallow still contains the brown testa of the seeds which is separated by pouring it into a

* *Agricultural Ledger*, 1904, No. 2, page 13.

cylinder made up of straw rings laid one on top of the other in which it is put into a rude press and the tallow is squeezed through in a pure state."

The yield is about 8 per cent. Lewkowitsch gives a yield of 15 per cent. of tallow and 15 per cent. of the stillingia oil from the kernels.

The second is a more simple method adopted in some parts of China when the shells with coating of tallow and the kernels are bruised in a stone mortar and the mass is boiled for some time in water or steam is allowed to pass into it. The fat is thus brought to the surface where it floats and is removed as a cake when the water beneath has cooled to the ordinary temperature of the air.

It will be seen that both these methods, though followed in China, are wasteful in the extreme, recovering only a fraction of the total tallow. Neither of these processes is recommended for adoption in India, and it seems that the preliminary experiments that gave unremunerative results were mostly carried out on the Chinese lines In a country where the tree occurs naturally in great abundance, as in China, it might pay to extract even a fraction of the fat, but it is difficult to make the same process succeed in India where the tree has to be cultivated at some expense.

The solvent extractio process.

The only process that would make the manufacture of vegetable tallow a remunerative industry in India is the extraction of the fat by such solvents as "Trichlorethylene" and petroleum benzine, etc. Modern Solvent Extraction Plants have now been perfected and not more than 5 per cent. of the solvent on 100 maunds of the seeds treated is lost in these plants and they are well adapted for the treatment of such materials as the seeds of *Vateria indica* or of the tallow tree.

For the preparation of the tallow, the whole seeds should be treated with the solvent, say, petroleum benzine, which would dissolve out of the white albuminous covering of the seeds, all the tallow contained therein. The solvent is then recovered and the

residual tallow freed from the last traces of petroleum benzine by blowing superheated steam into it.

For extracting the drying oil contained in the kernels, the seeds already treated with petroleum benzine are crushed and re-extracted with the solvent as before. The two products which, as is well known, differ in their chemical composition, are thus separated and obtained in the pure state.

The yield of tallow by this process is at least 50 per cent. more than that obtained by the crude Chinese methods and a similar quantity of drying oil is obtained as well, as a secondary product.

Data of yield of seeds *per acre.*

Owing to the absence of data as to the cost of creation and maintenance of plantations of this species *it is impossible to give figures representing* profit or loss resulting from the cultivation of this tree. It seems, however, probable that in spite of previous adverse reports the cultivation might be profitably undertaken provided up-to-date methods were adopted for obtaining the fat and oil from the seeds. It is after the figures of yield of seeds per acre come to hand that an exact idea of the profitable nature of the industry can be formed. It is a pity that no such data were worked out in connection with the preliminary and unsuccessful experiments referred to above. The following figures are quoted from Lewkowitsch :—" The tree commences to produce fruits at the age of four or five years and when it has reached its full development, it yields about 25—30 kilos of seeds per year."

The leaves.

The leaves of this tree are said to give a black dye in China. A preliminary investigation carried out on the autumn leaves indicates that there is no dye-principle in the leaves, as is shown by the following analysis :—

	First lot fresh leaves, per cent.	Second lot leaves fresh but mostly red, per cent.
Moisture	48·84	53·14
Total solids or aqueous extract	12·88	19·76
Non-tanning matter	10·05	15·62
Tanning matter	2·83	4·14

The tan liquor gives no reaction with bromine water, but produced a dirty greenish precipitate with lime-water. Ferrous sulphate gives a blue-black precipitate and ferric chloride a greenish black precipitate. The leaves were then treated in different ways to detect the presence of any dye-principle of an organic nature but with negative results. It has been suggested that the *fresh* leaves might contain the dye reported to occur in the leaves and this will be investigated as soon as such leaves are available, but positive results are improbable.

Ammonia in leaves.

When shade-dried leaves were treated with lime, they gave off ammonia. Ammonia was accordingly estimated in the leaves. The shade-dried leaves containing 13·66 per cent. of moisture gave 0·21 per cent. of ammonia.

Conclusion.

The results of the enquiry may be summed up thus :—

(1) That the cultivation of the tallow tree should be encouraged as a source of vegetable tallow and of the drying oil contained in the kernels of its seeds.

(2) That the tallow and the oil must be manufactured with the aid of a solvent extraction plant and not by bruising the seeds and steaming them as in China, because the yield of the tallow by the latter process is at least 50 per cent. less than that obtained by the former.

(3) That there is no dye-principle in the leaves worth extraction. The black dye, as produced by the Chinese, must be due to the action of iron mordants on the small quantity of tannin contained in the leaves.

(4) The leaves should make an excellent manure, and it is recommended that manurial field experiments be tried with it.

IRRIGATED PLANTATIONS IN THE PUNJAB.

BY R. N. PARKER, I.F.S.

PART II.

(Part I appeared in the August issue of the "Indian Forester," 1918.)

The Chichawatni plantation consists of two blocks separated by an unirrigated strip. The planting of the eastern block has been nearly finished, but no sowing has yet been done in the western block. The completion of the eastern block has been delayed by shortage of water at the season it is required for sowings, and this in spite of the fact that the canal irrigating the block has a greater discharge per 1,000 acres irrigated than was originally intended, as a large area it was designed to irrigate will be left unplanted. Unless the irrigation arrangements are altered, it will probably be found impossible to plant up the whole of the western block, or to maintain it even if it were planted.

The Khanewal plantation is the one where shortage of water is likely to be most acute. At Khanewal itself the soil consists of a superficial layer 3 ft. thick, of sand mixed with finer particles in about equal proportions, below which is a pure and rather course sand down to the water-level some 60 ft. or more below the surface. The section exposed at Khanewal in wells under construction is probably a fair sample of the whole. When the alkali has been washed out by irrigation and the superficial layer of soil has been broken up by roots of trees, it is obvious that the soil will absorb far more than the 2½ ft. of water allowed in irrigating Changa Manga. In Changa Manga, where the soil is stiff compared with Khanewal, strong winds in the hot weather do considerable damage to Shisham, especially when the soil is sodden after irrigation, and losses from windfall are likely to be much more serious in Khanewal.

The Tera plantation has been started to utilize a small supply of water which is available during the kharif in a distributary which irrigates land in the neighbourhood. Water will always be scarce and, for this reason, the plantation is being made with

Fig. 1.—*Dalbergia Sissoo*, 2 years old, unthinned, at Kot Lakhpat, irrigated plantation, Punjab.

Photo. Mechl.-Dept., Thomason College, Roorkee. Photo by B. Marsden.

Fig. 2.—*Dalbergia Sissoo*. Irrigated plantation at Kot Lakhpat, Punjab, showing edge of alkali soil. *In the distance 2-year old and 3-year old crops divided by road.*

trenches 15 ft. apart instead of 10 ft., and it is intended to keep the trenches open so that water can always be run along them instead of having to flood the whole area. The rainfall at Tera is about 20 inches against 15 at Changa Manga and about 8 at Khanewal, and the subsoil water is only 18 ft. below the surface so that the plantation will probably be successful in spite of the small supply of water.

Kot Lakhpat plantation was started in 1911 when 400 acres were ploughed and sown. This system had been thoroughly tried at Changa Manga and was eventually given up, so that it is not surprising that some 50 years later it was found no more successful in Kot Lakhpat. It was tried again in 1912, 1913 and 1914 with uniformly bad results; but, in these years, at the same time, the system evolved at Changa Manga after much experimenting was also used. Under this method, trenches are made 1 ft. wide and 1 ft. deep at 10 ft. intervals, and running approximately parallel to the contour lines. The soil excavated is thrown in a ridge on one side of the trench. A small berm 3—4 inches wide is made between the trench and the ridge, and raised an inch or two above the natural level of the ground. Seed is sown on this berm and watered by percolation from the trench. Shisham germinates in about 15 days, and during this period the seed must be kept moist. This is done by filling the trenches up to the brim, and allowing a constant flow of water to run into them sufficient to make good the loss by percolation and evaporation. When the seed has germinated, the water is shut off and the trenches are allowed to become dry. Subsequent irrigations in the first year consist in running sufficient water into the trenches to moisten them from end to end. Early March is the best time for sowing, but in irrigated plantations water is seldom given before the end of March and then only for a few days, after which the canal may be closed for three weeks for annual repairs. As soon as the annual closure of the canal (if there is one) is over, sowings can start but, at this season, the bulk of the supply is probably wanted by the two and three years' old crops, and only water that can be spared after allowing for the irrigation of the whole of the

previous year's sowings can be used for extension of the plantation. In July especially if there has been rain, plenty of water is available for new sowings, but it is not advisable to sow after the end of July, as the seedlings will have only two months' growing season and will have to endure six months (15th October to 15th April) without water. Sowings, after the monsoon has started, are not nearly so successful as those done during the hot weather, as the vigorous growth of weeds is apt to suppress the seedlings. The best sowings in Kot Lakhpat were made in 1915, an exceptionally hot dry year with no rain worth mentioning.

The number of waterings received by Shisham in the first year depends on the time the seed was sown and on the soil. The earlier the sowing was done and the more alkali the soil contains, the more often water is required. The maximum number of waterings given in the first year may be taken at 7 and the average at 3—4. In the second year, two waterings are advisable, and in *the following years only one is essential. This is for* Kot Lakhpat where the rainfall is about 20 inches. Whether it will also be the case in Khanewal, with a sandy soil and a rainfal of 8 inches, remains to be seen. In Kot Lakhpat the subsoil water is about 18 ft. below the surface, so that no great harm beyond loss of increment has been done by not irrigating some portions of the plantation till quite late in the season.

The results on good soil are all that can be desired as the accompanying illustrations show. Plate 26, fig. 1, shows *Dalbergia Sissoo* seedlings two years old. Plate 27 shows a crop six years old, which has been thinned once and will need thinning again in 3 or 4 years' time.

In irrigated plantations where the capital cost is high and annual irrigation charges have to be met, the financial results are materially affected by the thinnings, partly owing to the intermediate money returns but mainly owing to the shortening of the rotation as a result of thinning. The best interval between the thinnings and the age at which they should start has not yet been ascertained nor has the rotation to be eventually adopted been fixed as yet. In Changa Manga, the rotation was originally

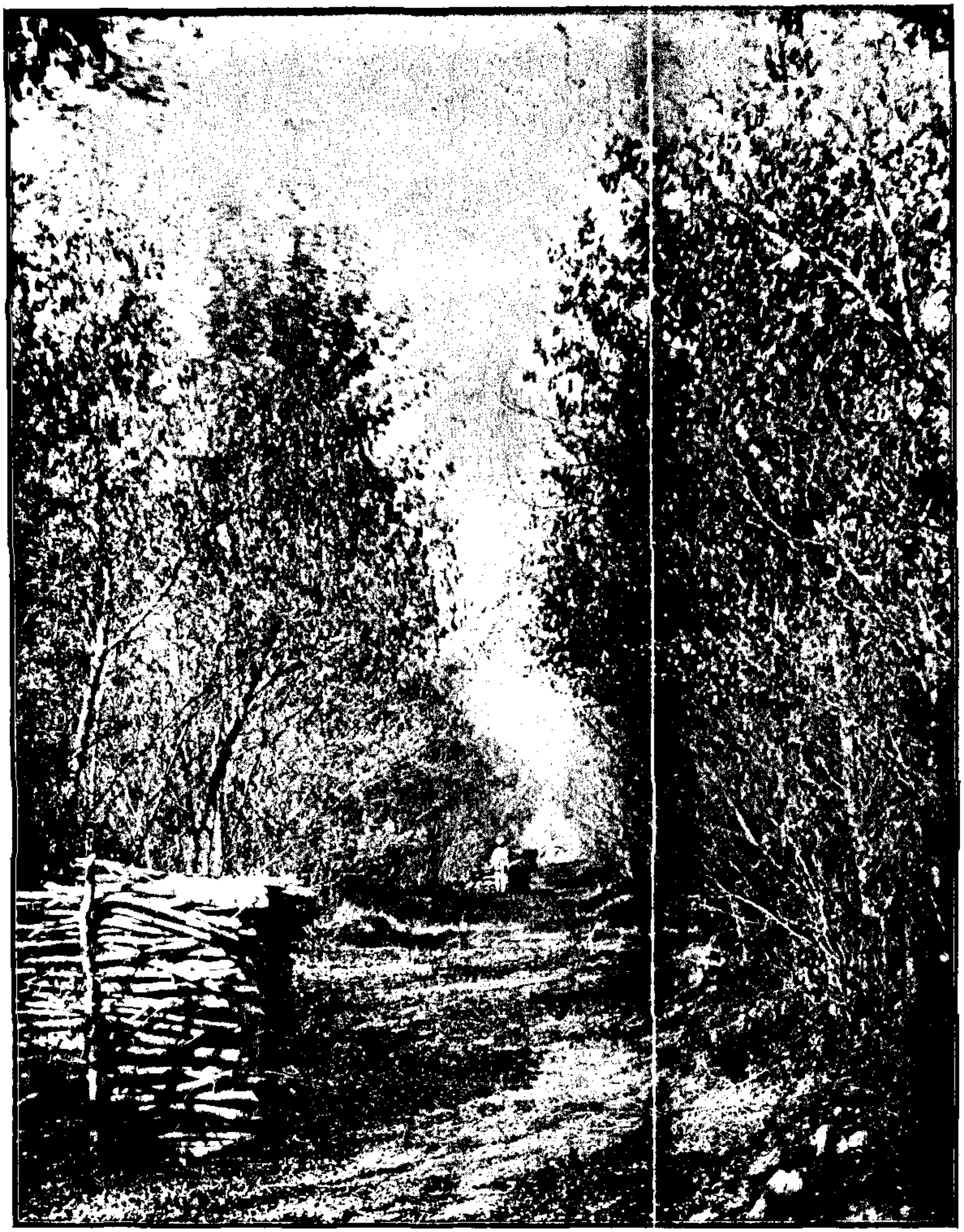


Photo. Mechl.-Dept., Thomason College, Roorkee. Photo by E Marsden.

Dalbergia Sissoo, 6 years old, just thinned, at Kot Lakhpat, irrigated plantation, Punjab.

15 years and has recently been raised to 20 years. It was found that without thinnings the longer rotation paid best; but now that thinnings have been prescribed, it is probable that the advantages which a 20 years' rotation has over one of 15 years could be obtained with a rotation of 18 years. The first final felling in the new plantations will probably take place at the age of 15 years, and it will doubtless be found profitable to raise the age in the second rotation.

In Kot Lakhpat, thinnings have been tried at the age of 1, 2 and 5 years At 5 years a thinning can be made, the yield of which will more than cover the cost, but at 1 or 2 years the produce cut is of no value, and thinning at such an early age is only justifiable if it benefits the crop. It has been found, however, that thinnings at one or two years are of practically no value as the stools of the plants cut coppice vigorously and, in a few months, the coppice shoots overtake the saplings, and a year later the crop looks as if it had not been touched. This would not happen if the thinning were made at the age of 3 or 4 years. A thinning at this age would certainly be unprofitable, but a second thinning could be made earlier than would be the case if the first thinning were made at 5 years. It is quite possible that it would be more profitable to make a thinning at 3 years old, at a loss, followed by thinnings at 7 and 11 years, and a final felling at 15 years, rather than to make the thinnings at 5 and 10 years and the final felling at 15 years. To settle this and similar points would take a whole rotation and the matter is complicated by scarcity of labour. It is clearly useless to prescribe more thinnings than can be carried out with the labour available, so for the present it is proposed to thin all crops at Kot Lakhpat when they reach the age of 5 years.

The cost of an irrigated plantation is high. In Kot Lakhpat, it costs Rs. 15-12-0 per acre for marking out and digging the trenches. Sowing costs Re. 1-14-0 per acre and 40 lbs. of Sissoo seed costing annas 8 is used per acre. Water charges amount to Rs. 2-12-0 per acre irrigated per annum, irrespective of the number of times water is given. In addition, there is the cost of the

establishment and coolies employed on irrigating, weeding, etc. The local coolie wage is 7 annas per diem.

Much difficulty has been experienced at Kot Lakhpat with bad soil. In a large portion of the plantation, the soil is heavily impregnated with alkali. The alkali, in addition to the injurious effect it has on plant growth, makes the soil very impervious to water. It occurs in irregular bands and patches interspersed with good soil and is always easily recognized by the vegetation which is different to that found on good soil. Sometimes areas are found in which the soil is not heavily impregnated with alkali but contains an appreciable amount. In these cases irrigation usually tends to cause the alkali to collect into patches, leaving the rest of the area free from alkali. In one plot, in Kot Lakhpat, this process has been watched. The plot was sown with Sissoo in the usual manner and the result appeared quite satisfactory, the lines of seedlings being complete. The growth of the seedlings was, however, slow and the plot seemed to be suffering from want of water, so it was watered from time to time out of its turn. Instead of improving, however, the plot as a whole became worse. Although in places the seedlings responded, in many parts they died and, in these places, a white efflorescence of salt appeared showing the cause of the death of the plants which had not previously been suspected. Now the plot consists of patches of good growth alternating with blanks.

Efforts have been made to stock bad soil by sowing other species than Sissoo, but they have all failed for the same reason that Sissoo fails. Under the system employed the seed is moistened by percolation from the trenches, but in alkali the water will not percolate. If the trenches are overfilled so that the water flows over the berm on which the seed has been sown, the soil gets caked and the seed rots. Even when the trenches are filled to the brim, the water does not percolate to the seed, and in alkali the sides of the trenches rapidly subside causing the seed to fall into the bottom of the trench where it rots in the water. In bad cases, after irrigating a plot of alkali and then allowing the trenches to dry, if one digs in the bottom of the trench one may

find that the soil has been moistened to a depth of 2—4 inches only and below this is quite dry and very hard in spite perhaps of water having stood in the trenches for a month before it finally dried up by evaporation. Consequently, on such soils, when germination has been obtained by rain or very careful watering, the seedlings remain stunted and can only be kept alive by much more frequent irrigation than it is possible to give.

There is no doubt that these patches of alkali will eventually disappear. Every time they are irrigated they improve somewhat and the water sinks in deeper. Certain plants come up with the irrigation, especially a grass—*Sporobolus arabicus*, Boiss., which is usually the first plant to appear and soon covers the soil. Plate 26, fig. 2, shows a patch of alkali. On the right of the picture the growth of the Sissoo is excellent and the sharp line dividing the good soil from the alkali, which is very characteristic, will be noticed. At the junction of the good and bad soil is a fringe of *kana* grass (*Saccharum Munja*, Roxb.) which owes its presence to the lateral light admitted to the good soil by the blank. This grass gives a good deal of trouble especially if owing to shortage of water or any other cause, the growth of the Sissoo is checked, as it soon overruns the whole area. At the same time if kept down by stubbing it out as soon as it appears, it is easily kept in check, and as soon as the Sissoo saplings begin to form a complete canopy, it is killed out as it cannot endure shade. The alkali patch shown in the picture has been densely covered with *Sporobolus arabicus* and contains scarcely anything else. When other grasses begin to appear it will be a sign that the soil has improved, and we shall then be able to re-sow Sissoo with every prospect of success, but *kana* grass is likely to give trouble as it rapidly overruns any blank unless the blank is due to alkali.

NOTES ON EUROPEAN FOREST RESEARCH.

BY S. HOWARD, I.F.S.

Talk of the appointment of provincial sylviculturists is in the air. I spent a year in Europe in 1911-12, much of which was devoted to the sylvicultural research then going on. Some three and a half months were spent working in the Prussian Research Institute and much of this article concerns Prussia but Prussia will serve as an example. Possibly some useful hints may be derived from it which may be of help in India.

In 1892 an International Forest Research Association was founded. This met at Mariabrunn, 1893, Braunschweig, 1896, Zurich, 1900, Mariabrunn, 1903, and in Belgium in 1910. I believe it also met in Petrograd in 1905 but I can find no record of this at the moment. Most European countries are members but France, I think, is not. If she is, she has taken no active part. The reason is not that France does not realize the value of the association but, so an eminent French forester informed me, if France were a member, the Association would sooner or later hold a sitting in Nancy, and if a party of Germans paraded the streets of Nancy there would certainly be trouble.

The events which led up to the formation of this association, as far as Germany is concerned, were as follows :—

Forest Research, in many instances, necessitates observations over long periods of time, longer than an individual man's working years, and over widely separated areas. Some institution is necessary, therefore, to direct methods for the sake of uniformity and to continue ideas despite the necessary changes in the Research Personnel.

Wedekind pointed this out as long ago as 1826, and in 1845 Carl Heyer issued a treatise concerning the foundation of an association to control research matters. About 1860 this was repeatedly advocated by Gustav Heyer, Baur, Gayer and Ebermayer to mention only some.

In 1867 Gayer sketched an organization for research institutes, and in 1868 Baur wrote an article on organization and the methods of conducting experiments.

The first real move made was at a meeting in Vienna in 1868 where a proposal was put forward to elect a committee of five who should—

(1) prepare a scheme of Forest Research;
(2) draw up a list of the most pressing work;
(3) discuss the best method of organization;
(4) draw up rules.

The committee elected were Wessely, G. Heyer, Ebermayer, Judeich and Baur representing most of Germany. This committee wasted no time.

They met in Regensburg in November 1868. It was there decided that the larger states, Austria, Prussia and Bavaria, should have independent Research Institutes. For the smaller states the professors in the various forest colleges were to undertake research work as part of their duties. Among other things, they discussed the advisability of forming an association to further forest research and suggested an international association.

These proposals started a mass of controversy and finally in June 1870, as a result of an article by Danckelmann followed by a memorial to the Finance Minister, it was decided that forest research should be properly organized *but* the research institutes in all the states were to be combined with the educational branch. That is to say, the President of the Forest College was also to be President of the Research Institute.

As far as I can ascertain, Germany was the first country to organize its research and to found a Forest Research Association. The German Forest Research Association, although it really dates from the committee of five at Regensburg in 1868, was formally created in 1872. Germany has probably done more for Forest Research than any other European country and it was as a result of German activity that the International Forest Research Association was founded in 1892.

The usefulness of these International meetings cannot be over-estimated. For example, it was soon found essential to have some classification of thinnings, if results were to be comparable. The classification of thinnings, which I wrote in the *Indian Forester* in February 1916, was the Prussian classification adopted by the International Association in 1903 as nearly as it can be rendered in English.

FRENCH RESEARCH.

Instructions were issued in France in 1882 for organizing forest research. The research stations were to be under the control of the President of the Nancy Forest College. All experiments were to be proposed to the President and discussed by the President, Professors and Forest Officers attached to the college. An account of the experiment was to be compiled by the officer n charge of that branch and a record of the commencement of the experiment had to be sent to the "Directeur" of Forests. Every experiment was to receive a name and number and its progress was to be entered in a register which was to be always at the disposal of the college professors if they needed it Any chemical analysis needed by the Forest Officer in charge of the experiments was to be made in the college laboratory. Reports of progress were to be submitted to the "Directeur" of Forests who was to order publication if necessary. A report of the work and the expenditure incurred was to be made yearly in January by the President of the College and sent to the "Directeur" of Forests. I regret that my notes do not make it clear whether the carrying out of the experiments was done by the college professors and officers or whether the local officers performed the work, but from what I saw in France I am inclined to think the college staff did the work.

The above was not a bad start but it was hopelessly carried out. Experiments were begun but were usually badly organized and badly performed. I see from my notes that there was an "experiment to study volume production in regular crops of Silver Fir—two experimental plots started in 1884 in the Dominale Forest of Rambervillers." Imagine it! Two plots for such an experiment and an article was written on the results in 1889!

It is a great pity France took no active part in the International Association. The hopeless inferiority of French Research is put down by French foresters to lack of men and money and bad organization. If France had attended the International meetings, enough interest would probably have been stimulated for men and money to be forthcoming and, at any rate, much would have been learnt about organizing research. Experiments ceased absolutely between 1896 and 1902. The last proposals I heard of in France were, that various departments of research should be inaugurated (undoubtedly founded in the Prussian departments) to be controlled by the "Directeur" of Forests or by some one chosen by him. The elements of an association were outlined with the "Directeur" as head, college professors who were interested, three conservators and two outside members, one a timber merchant and one a private forest proprietor. It was also decided that it would be better to have a special paper for research publications rather than that they should be published in various forest and agricultural journals as had been done in the past.

It was considered that the work proposed cost about £1,200 per annum. Considering the richness of French forest, this expenditure is nothing when it is remembered that Germany spends £6,000, Switzerland £2,000 and Sweden £880 roughly.

In 1911, however, these proposals had not materialized and a professor at Nancy informed me he was not very hopeful about them. He confessed that French Research was severely handicapped by not taking part in the International Association.

German Research.

The history of German Research has been already written above. In 1912 all German states of importance had their Forest Research Institutes (combined with the college) united under the German Forest Research Association (which meets as a rule twice a year), and this, in turn, united with the International Forest Association.

The Prussian Research Institute.—This will serve as an example of research organization in Germany. It was started in 1871, though not officially created till 1872, and it is united with the Forest College at Eberswalde. There are six branches :—

1. Sylvicultural branch.
2. Physical-chemistry branch
3. Meteorology branch.
4. Plant physiology branch.
5. Zoology branch.
6. Mycology branch started in 1899.

The head of the sylvicultural, physical-chemistry and mycology branches are specially appointed men though they deliver certain lectures in the college. The heads of the other branches are the college professors of those subjects.

Besides the head-quarters at Eberswalde, there are numerous plots all over Prussia. The original orders were that the local forest officer should be in charge of the outstation experiment under the control of the "Regierungsforstbeamten" and directed by the Research Officer. This did not work. Pressure of other work, lack of technical knowledge and training in experimental work, and various other reasons all tended to show that the local forest officer is not the man to carry out the experiments, and although the original orders are still in force on paper, for more than 20 years all work connected with the plots has been done by the research staff.

In all branches researches are made over as wide an area as possible.

The President of the Research Institute must be in close touch with all work, and the experiments are all discussed by the German Forest Association.

The total expenditure of each branch is allotted by the President, but the actual details of spending the money are entirely controlled by the head of the branch in question.

It may be of interest to show briefly the kind of work done by each branch. This is not an exhaustive list but simply an indication.

1. *Sylvicultural branch.*—I know more about this than the others. When I was there, the staff consisted of Dr. Schwappach as head, with Assessor Rohrig (quite a junior officer) as assistant. Under them were two officers of the subordinate service Local foresters assisted in the purely mechanical work of felling sample trees, in thinnings, etc., but not in marking them for felling.

The principal work of this branch is the compilation of yield tables and the collection of statistics connected with them.

During the summer months, the plots for that year were thinned by Schwappach, Rohrig, Jones or myself, not by the subordinate staff, and then measured and entered up by one of us, assisted by one of the subordinate research officers. The results were all worked out in Eberswalde during the winter The curves were drawn by Schwappach himself, though a discussion was first held by the four of us as to its course. The plots extend throughout Prussia; I was working that summer near Posen.

Other work which this branch has taken up are:—relations between stacked and solid volume, experiments with exotics, experiments concerning root-formation, manure experiments, experiments on the technical properties of wood (with the technical and experimental station at Charlottenburg), seed tests, etc, etc.

It is worth noting that the tests of strength of wood, etc., are done by technical experts at Charlottenburg, and not by the Forest Research Institute, and that the sylviculturist represents the forest side of these experiments.

2. *Meteorology branch*—This is especially concerned with experiments concerning the influence of forests on climate and not so much with the reverse. All sorts of observations on temperature, humidity, winds, etc., are made.

3. *Plant physiology branch.*—This is purely botanical. It takes up such subjects as researches on iron bacteria, formation of annual rings, grass floras, influence of the district on seeds, influence of soil factors on plants, natural distribution of forest trees, etc.

4. *Zoology branch.*—Concerned with zoological researches, as far as they concern forests, and with control methods.

5. *Physical-chemistry branch.*—Concerned with the chemistry of soils, humus formation, pan formation, etc., etc.

6. *Mycology branch.*—Purely concerned with mycology in its relation to forestry and control methods.

A FEW REMARKS.

Judging from European experience, it appears that each province should conduct its own researches. The provincial sylviculturists will be the first step towards a proper research staff in the various provinces in India. Beyond this point, however, decentralization is a mistake. The methods and ideas must be controlled by a central body, if any unity is to be obtained. Thus the various experiments in each German state are carefully discussed, and an exact procedure and method is passed by the German Forest Research Association before the experiment is started. Not only does this make for scientific method, but it prevents unnecessary repetition of work. Whether a central research institute at Dehra Dun will be necessary once the provincial institutes are begun is an open question.

The writer thinks it is unnecessary, but *some* central board of control is absolutely necessary; and, for the present, the Dehra Dun Institute, combined with the Board of Forestry, takes the place of a Forest Association.

India should certainly become a member of the International Forest Research Association. Even if no Indian forester ever attended the meetings, the society's proceedings would greatly benefit Indian Forest Research. A few years ago, suggestions of introducing European methods into India were often greeted with the remark that "Indian conditions" rendered European methods impossible. It is about time this ghost was laid. Local conditions certainly influence all work, but they influence *details* far more than *principles*.

In Indian Research work (I speak of sylvicultural research and the collection of statistics) mistakes have been made which

are merely a repetition of mistakes made formerly in Europe but which have been solved now and the European solution is often directly applicable to India. If the Forest Research Institute had been from the start a member of the International Research Association, many of these mistakes could have been avoided, to some extent at any rate. I imagine the Association is defunct at present, but there is no doubt it will be revived after the war.

SYLVICULTURE IN THE CENTRAL PROVINCES FROM THE TAX-PAYER'S POINT OF VIEW.

BY THE HON'BLE J. W. BEST, I.F.S.

During the last three years the gross annual revenue from Government forests in the Central Provinces has risen from Rs. 28,90,062 to Rs. 34,10,595, and this increase has been mainly obtained by the more intense working of our annual coupes and by the improved timber market. In the year 1916-17 the net income which the Central Provinces tax-payers gained from their forests' property was Rs. 16,19,913 compared with Rs. 10,20,490 in the five years previous to 1915-16. It is true that in the United Provinces a similar satisfactory increase of revenue has occurred and the *Pioneer*, in its leading article of April 4th, shows a jusd appreciation of this, but I think is hardly justified in its somewhat pharisaical remark that "we may hope that the time is not far distant when other Local Governments will come into line with that of the United Provinces, and deal with their forests in the same generous spirit investing in them the money so badly needed for their development." Our record is not so bad, although our staff has been much reduced by a number of officers being permitted to join the I. A. R. O., considerably more so than is the case in the United Provinces. I believe I am correct in stating that it was in the year 1910-11 that Mr. Hart, then Chief Conservator in the Central Provinces, pointed out to the Local Government the necessity for the construction of a system of good fair-weather roads for the proper exploitation of the capital lying idle in the hitherto almost inacessible forest products of the

province, more particularly of timber. This resulted in a five years' road programme being sanctioned, and the prospects of funds being provided to carry it out.

As an illustration of the results of the sound investment of capital in forest communications, I quote the following case:—

In the seven years up to the year 1910-11, the average expenditure on roads in the Rahatgaon and Magardha Ranges of Hoshangabad Division was Rs. 204. This was merely sufficient to keep the existing tracks in repair.

The total gross revenue from the timber and firewood of the forests in this period was Rs. 93,751. From the year 1911-12 to the present time a sum of Rs. 18,310 has been expended on the construction of roads, during which period the gross revenue *from timber and firewood has been Rs. 2,78,951 and so far in the* year 1917-18 it is Rs. 1,12,550.

Of course it cannot be said that this large increase is *entirely* due to the money spent on roads. Yet, doubtless, if the money had not been so spent, the increase in revenue could not have taken place.

A return of Rs. 1,85,200 for an expenditure of Rs. 18,310 in seven years cannot be said to be a bad investment.

A road system is, however, only a means to an end in making possible the sale of produce hitherto unsaleable. What we have to ask ourselves is whether, now that communications are open, the Central Provinces tax-payer is getting the most profitable rate of interest on his forest capital of tree growth. In other words, have we any real idea of what the financial rotation of our Central Provinces forests is? We have no Research Institute and are not so happily placed as the United Provinces in this way, but this should not mean that where it is possible no efforts should be made to ascertain the financial rotation of the different kinds of forests in each forest division. Roughly, the tree forests of the Central Provinces can be divided into two main groups as regards their sylvicultural treatment. The more remote forests and those which are likely to produce large timber are being treated under what are vaguely termed "Improvement Fellings." This

may mean anything but, in most cases, involves selection fellings and cleanings combined. Where there is a demand for small poles and for firewood, or where there is little likelihood of large timber being grown, the forests are treated under the coppice-with-standards system of felling, although this treatment is, in some cases, called "Improvement Fellings." The first so-called improvement fellings generally apply to Sal and teak forests.

Owing to the absence of annual rings, it is not possible to ascertain the rate of growth of Sal except by the formation and periodic examination of sample plots. The difficulty with sample plots is that, owing to the frequent transfers of officers, they are sometimes forgotten. This branch of research was recently taken up by the Sylviculturist and I believe that the results of his investigations were not very flattering to the capacity for growth of our local Sal.

In the case of teak, however, we have, in the annual rings which can be counted when coupes are felled, ample means of ascertaining the rate of growth and so forming some idea of the financial rotation.

When I took over charge of the Hoshangabad Division in the year 1914 I had, as I now realize, too conservative views on the danger of over-cutting in teak coupes under the so-called improvement fellings. After discussing this question with my Conservator, I set myself out by collecting statistics to prove that he was wrong with the result that I have successfully proved that he was right. With the help of Mr. George, I.F.S., and Mr. McDonald, P.F.S., the girth and height-growth of over 4,000 felled teak trees were recorded; and after dividing the results into two classes, two useful curves of mean growth were obtained. In addition, I have collected, for over two seasons, information from market reports of the relative value of logs according to their girths. After deducting the cost of cutting, extraction and maintenance and by ascertaining the measurements of a large number of trees, I have been able to get some idea of the financial rotation for teak in the two classes into which I have divided it. In Hoshangabad the demand comes from Hyderabad, Khandesh,

Indore and up-country for teak wood, and the length which has been found most suitable for transporting to the market and to meet the demand, is of thirteen feet. This standard length is remarkably constant, and when a felled tree is cut up by a coupe lessee, he aims at getting as many as possible of the standard thirteen feet logs. I have, therefore, calculated the value of the tree at its various ages from the number and girth of the standard logs which records show that it may be expected to yield. When a coupe is near the market, a demand arises for smaller logs and firewood. The values of these, however, are slight compared with the values of the standard logs, and I have not taken them into consideration in the preparation of the tables, but this must be remembered when considering the values in column 11 of the table shown below as well as the fact that the trees measured were those felled under the improvement fellings system and represent a rate of growth lower than that which we can expect in the future from improved methods of conservancy. The cost of maintenance shown in columns 6 and 10 is low and the calculation was made as follows:—

More than half the revenue of the division comes from timber and firewood, and $\frac{9}{10}$ths of the revenue from timber and firewood is derived from teak wood. It is fair, therefore, to put half the cost of the annual expenditure to the maintenance of teak trees. This amounts to Rs. 50,865 per annum. If we multiply the average number of teak trees felled each year by the number of years which we know from columns 1, 2, and 3 it takes for a tree to reach maturity, we get the figures 1,11,04,145 which very roughly represents our stock of trees on which the Rs. 50,865 per annum is expended. Thus the cost of looking after one tree per annum is ·0073 annas. This calculation is probably unsound mathematically but is, I think, good enough to work on. I can think of no other way of calculating it. It will be seen that trees with a maximum height-growth of over 50 ft. after 40 years' growth come into the first class while those below are relegated to the second class.

Taking the table for first class teak: If only one standard log is grown per tree, then the figures in columns 7 and 8 show

that it would not pay the tax-payer to grow his trees beyond a 20 years' rotation because from the year 20 to the year 25 the value of the tree increases from Re. 1-2-0 to only Re. 1-3-0 whereas the sum of Re. 1-2-0 (value at 20 years) if put out at 4 per cent. compound interest would in the same period of five years be worth Re. 1-6-0.

Therefore, under these circumstances, it would be better to cut the tree at age 20, put the money in some other investment and grow another tree. The above conditions are, however, not natural as the figures from collected data in columns 11 and 12 show that more than one standard log can be expected from most trees In the case of a first class tree, columns 11 and 12 show that mathematically it does not pay the tax-payer to grow a tree beyond 35 years. After 30 years' growth, a first class teak tree is worth Rs. 2-1-0; and after 35 years, Rs. 2-7-6 compared with Rs. 2-1-0 plus compound interest in the same period which comes to Rs. 2-8-0. If the tree is felled at 35 years and another grown in its place, then, after a second rotation of 35 years, the tax-payer will get Rs. 2-8-0

	Rs.	a.	p.
plus compound interest for 35 years	9	12	0
plus one teak tree, 35 years old	2	7	6
Total ...	12	3	6

compared with Rs. 7-6-0 if the first tree is allowed to grow for a further 35 years instead of being felled and its value put out to interest.

Similarly as regards the second class trees shown in the second table, the mathematical financial rotation would be 35 years when the tree is worth about Re. 1-7-0. By investing this amount the tax-payer after the second 35 years could get—

	Rs.	a.	p.
Re 1-7-0 plus compound interest ...	5	10	0
One teak tree, 35 years old	1	7	0
Total	7	1	0

compared with Rs. 2-11-6 if he had allowed the tree to go on growing for the full 70 years.

By continuing to grow a tree up to 70 years, the Government thus loses, in the case of first class trees, Rs. 4-13-6 per tree, and, in the case of second class tree, Rs. 4-5-6. This is the case of *one tree only;* but to appreciate what this means to the tax-payer, the figures have to be multiplied by a good many thousand trees. The mathematical financial rotation would, in some cases, probably be a little shorter, say 30 to 32 years, as I have not taken into account the value of firewood and small pieces which can only find a local market in the few felling-series which are close to the demand.

As is well known, the financial rotation is not the sole consideration when determining the age at which trees should be felled, but should be the main factor in fixing it. Such considerations as a limited but urgent demand for the production of some large timber, climatic considerations, local industries, possible changes in the sizes required owing to improved conditions of house-building, communications, etc., and the danger of flooding the market with too large a supply of one particular size of produce all require careful thought.

The timber is required for house-building, and I see little likelihood of any radical change in the size of houses and the requirements of timber for them during the next hundred years in this country. To be on the safe side, it would be sound policy to grow the few first class teak forests, which we have, on a 60 years' rotation from which we could expect four feet girth logs, and to treat the second class (the majority) under the coppice system with a rotation of 30 years. Where there is danger of frost, it may be necessary to maintain the few first class trees as standards in the interests of the coppice.

I cannot claim that my figures would be applicable to the rest of the province but think that they may be, and that the collection of similar data in other forest divisions would give Government some most useful information.

As regards the forests already under the coppice-with-standards system, whether teak or otherwise, there are now in many divisions, more particularly the Nagpur, Wardha and Bhandara divisions, many square miles of coppice shoots, *of known age*

varying from age one year to nearly thirty years, from which it would be possible to collect most accurate figures of the rate of growth of most of the species now being coppiced in the Central Provinces. Hitherto, in coppice, we have blindly worked on the basis of a thirty years' rotation giving as our reasons for this, in working-plans, the fact that we had no data for calculating the correct rotation, and that thirty years seemed a suitable period. Such haphazard methods were the only possible way until recently. Now that we have the means of ascertaining the financial rotation from actual coppice growth, it is up to us to find out whether the tax-payer's forest capital is laid out in the most profitable manner in view of local and special conditions.

I wish to acknowledge with thanks the help given me in working out my curves by Mr. Marsden, the Sylviculturist, and more particularly by Mr. Howard, I.F.S., of the United Provinces.

Hoshangabad Division, C. P., teak, first class.

Age.	Height in feet.	Height in inches at 4½' from the ground.	CALCULATION ON THE ASSUMPTION THAT THE TREE CONTAINS A LOG OR POLE 13' LONG. Average market price of one 13' log, allowing for squaring.	Cost of cutting, carting, etc., 13' log.	Cost of maintenance of one tree, annas and pies.	Nett value, *i.e.*, cost 4 − (5+6).	Previous value plus compound interest @ 4%.	CALCULATIONS FROM MEASUREMENTS OF FELLED TREES. Tree value after deducting expenses before arrival in market.	Cost of maintenance, annas.	Nett value of tree.	Previous value plus compound interest @ 4%.	REMARKS.
1	2	3	4	5	6	7	8	9	10	11	12	13
			Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p	Rs. a. p.	Rs. a. p.	
5	14	7		...	...	...	...	...	...	...	...	
10	21	13	0 8 0	0 3 6	...	0 4 6	...	0 4 0	...	0 4 0	...	
15	27	17	1 14 0	0 6 0	...	0 14 0	0 5 6	0 14 0	...	0 14 0	...	
20	33	21	1 9 0	0 7 2	...	1 2 0	1 1 0	1 3 0	...	1 3 0	...	
25	38	25	1 12 0	0 9 0	...	1 3 0	1 6 0	1 10 0	...	1 10 0	1 7 0	
30	43	30	2 0 0	0 12 0	...	1 4 0	...	2 1 0	...	2 1 0	2 0 0	
35	47	33	2 4 0	0 14 0	0 0 6	1 6 0	...	2 8 0	0 0 6	2 7 6	2 8 0	
40	50	37	3 0 0	1 5 0	0 0 7	1 10 0	2 7 0	2 14 0	0 0 7	2 13 6	3 0 0	
45	53	40	5 0 0	2 0 0	0 0 8	2 15 0	...	3 6 0	0 0 8	3 5 0	...	
50	56	45	9 0 0	2 7 0	0 0 9	6 8 0	...	4 0 0	0 0 9	3 15 0	...	
55	58	47	10 0 0	3 0 0	0 1 3	6 14 0	...	4 14 0	0 1 3	4 12 5	...	
60	60	50	13 0 0	3 0 0	0 2 0	9 14 0	...	5 14 0	0 2 0	5 12 0	...	
65	62	52	15 0 0	3 0 0	0 2 1	11 13 0	...	6 0 0	0 2 1	5 14 0	9 13 0*	*Rs. 2-8-0 for 35 years at compound interest.
70	62	54	17 8 0	3 2 0	0 2 7	14 3 0	...	7 8 0	0 2 7	7 6 0	...	
75	62	55	19 0 0	3 9 0	0 3 4	15 7 0	...	8 8 0	0 3 4	8 5 0	...	
80	62	56	20 0 0	3 12 0	0 4 1	16 0 0	...	9 0 0	0 4 1	8 12 0	...	
85	62	56	20 0 0	3 12 0	0 5 4	15 15 0	...	9 14 0	0 5 4	9 9 0	...	
90	62	56	...	...	0 6 10	...	...	10 8 0	0 6 10	10 1 0	...	
95	62	56	...	...	...	...	...	...	...	...	...	
100	62	56	...	...	...	...	...	...	...	...	...	

Hoshangabad Division, C. P., teak, second class.

Age.	Height in feet.	Height in inches at 4½' from the ground.	Calculations from measurements of felled trees. Tree value after deducting expenses before arrival in market.	Cost of maintenance, annas.	Nett value of tree.	Previous value plus compound interest @ 4%.	Remarks.
1	2	3	4	5	6	7	8
			Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
5	11	3	...	...	...	...	
10	18	6	...	...	...	...	
15	22	9	...	...	...	...	
20	26	11	0 8 0	...	0 8 0	...	
25	29	15	0 15 0	...	0 15 0	0 9 8	
30	32	17	1 3 0	...	1 3 0	1 2 0	
35	34	20	1 8 0	0 0 6	1 7 6	1 7 0	
40	36	22	1 9 0	0 0 7	1 8 0	1 12 6	
45	38	25	1 11 0	0 0 8	1 10 0	...	
50	40	27	2 0 0	0 0 9	1 15 0	...	
55	42	30	2 3 0	0 1 3	2 2 0	...	
60	44	32	2 8 0	0 2 0	2 6 0	...	
65	45	34	2 11 0	0 2 1	2 9 0	...	
70	47	35	2 14 0	0 2 7	2 11 0	5 10 0*	* Re. 1-7-0 plus compound interest for 35 years.
75	48	37	3 1 0	0 3 4	2 14 0	...	
80	48	38	3 2 0	0 4 0	2 14 0	...	
85	49	39	3 4 0	0 5 4	2 15 0	...	
90	49	39	3 6 0	0 6 10	2 15 0	...	

MANUFACTURE OF MATCHES IN RANGOON.

BY A. J. BUTTERWICK, P.F.S.

At the end of 1911 and the beginning of 1912, the writer was placed on special duty to mark timber for the match factory of Messrs. Lim Soo Hean & Co., Rangoon, in the Mahuya and Paunglin Reserves, Hlegu Range, which, at that time, was a portion of the Pegu Forest Division. The match industry in Rangoon was then in its infancy, and it was not known for certain at that time what timbers were suitable for it or not. According to orders received, the writer marked the following species for the match firm :—

1. Letpan (*Bombax malabaricum*).
2. Didu („ *insigne*).
3. Thitpok (*Tetrameles nudiflora*).
4. Setkadone (*Trewia* „).
5. Tein (*Stephegyne parvifolia*).
6. Taung thin baw (probably a species of *Sterculia*).
7. Ma-u (*Anthocephalus Cadamba*).
8. Odein (*Ehretia lævis*).
9. Shawbyu (*Sterculia fœtida*).
10. Hmondaing (*Kokoona littoralis*).
11. Taungmeok (*Alstonia scholaris*).
12. Budalet (*Elæocarpus lacunosus*).
13. Gwe (*Spondias mangifera*).
14. Thayet (*Mangifera indica*).

The above particular kinds were very probably selected as an experimental measure, as their timber was lightish in colour, and the logs floated easily even when green. The habitat of almost all of them was the damp evergreen forests, which are so commonly found covering the alluvial land along streams, and which are annually inundated during the rains. One of the predominating species of these forests is a kind of cane called danon or zanon (*Calamus arborescens*). The logs obtained from the above-mentioned trees were floated down to Rangoon by way

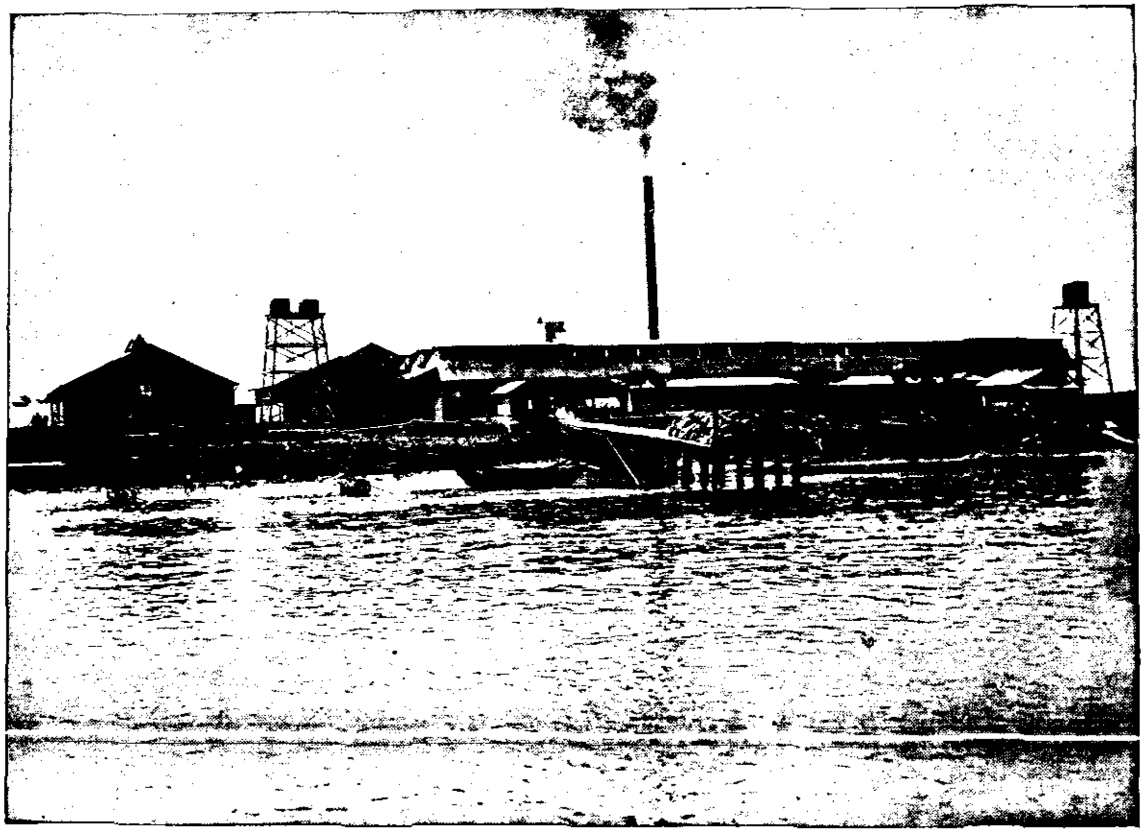


Photo. Mechl.-Dept., Thomason College, Roorkee.

Match Factory of Messrs. Lim Soo Hean & Co., Rangoon.

of the Mahuya and Paunglin Chaungs, which in conjunction formed the well-known Pazundaung Creek.

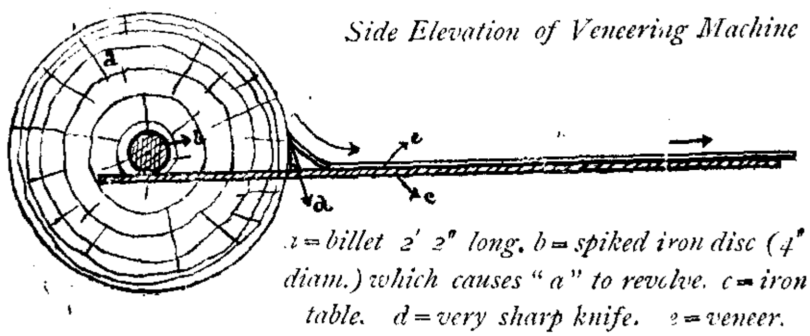
2. At that time, the writer was very keen to visit the match factory in Rangoon and see which timber was found suitable for the industry and which unsuitable. As he was shortly after transferred from the Pegu Division to the Forest School, Pyinmana, opportunity did not offer for some time. In December 1917, however, when on tour with the students of the Forest School, a visit to the Rangoon match factory was one of the items of the itinerary. The proprietors, Messrs. Lim Soo Hean & Co., not only allowed the School to see their match factory at work, but also very kindly deputed one of their representatives to explain to the students all the different stages in the manufacture. From that visit and also from a subsequent letter from the firm, the following notes have been compiled. The writer is much indebted, therefore, to Messrs. Lim Soo Hean & Co., Rangoon, for all the help given, and ventures to publish herewith the information obtained from them in the hope that it may be of some interest to the readers of the *Indian Forester*. The photo of the match factory published herewith (Plate 28) was also obtained from the managing firm.

3. The factory is situated on the right bank of the Rangoon river, 6 miles below the capital, near a village called Kanaung. As far as it was gathered, the site was chosen for no other reason but that Messrs. Lim Soo Hean & Co had a rice factory there originally, and it was thought that the machinery of both could be worked by one superior Engineering staff. Besides this, the site was very convenient for a match factory being close to Rangoon and right on the banks of the river. The factory was opened in 1909. The only timbers which are at present in use in it are Letpan (*Bombax malabaricum*) and Shawbyu (*Sterculia fœtida*). The former is used for the box-covers and for the sides of the drawers, the latter for the splints and for the bottoms of the drawers. Messrs. Lim Soo Hean & Co. have found all other woods a failure for one reason or other. Even the Shan States pine (*Pinus Khasya*) has been tried, but it too was found to be unsuitable as the knots in the wood chipped the sharp keen edges

of the peeling knives in their machines, and the exuding resin clogged their machinery. The Letpan and Shawbyu logs are at present obtained chiefly from the Shwegyin Division on the Sittang river; Government duty costs the firm Rs. 2 a ton and carriage from Shwegyin to Rangoon *viâ* the Pegu-Sittang Canal Rs. 13 a ton.

4. The following essentials are required in the Letpan and Shawbyu logs. They must be green and as cylindrical as possible. Also the timber must not be spongy and brittle like cork, as this causes the veneers to break off during the peeling. Logs ranging in girth from 4′ 6″ to 9′ (without bark) are most in demand. Each log is dragged up a slipway from a small inlet from the river. The bark is then removed by hammering and hand-peeling. This bark is useless for cordage, as salt water has thoroughly soaked into it and ruined its usefulness. After the bark has been torn off, the logs are cut up into lengths of 2′ 2″ by a straight cross-cut saw worked by a small machine. Each 2′ 2″ piece is then placed on to the veneering or peeling machine, a rough drawing of which is given below.

Side Elevation of Veneering Machine



a = billet 2′ 2″ long. b = spiked iron disc (4″ diam.) which causes "a" to revolve. c = iron table. d = very sharp knife. e = veneer.

The log is revolved round at a great speed towards the table, which is about 12′ long, and, at the same time, the knife keeps eating into it, advancing very gradually according to requirements. Thin sheets of wood varying in thickness from $\frac{1}{100}$″ to $\frac{1}{10}$″ are, therefore, rolled on to the table and helped on by men standing along the sides. At the commencement, the first 2 or 3 sheets are

broken and non-continuous, as the logs are very seldom cylindrical. These are rejected until continuous sheets of wood are obtained. In a very short time the log is whittled down to a cylinder about 4" in diameter. This is rejected as the wood near the pith is considered too spongy and brittle for veneers. There are altogether five such veneering machines, one for the splints, one for the bottoms of the drawers, one for the sides of the drawers and two for the box-covers. The first two kinds use Shawbyu timber and the next three Letpan. The machine, which peels the logs for the splints, divides at the same time the wooden sheets into halves; each half, therefore, being about 1′ 1" broad. The machine for the bottom of the drawers at the time of peeling also divides the sheet into 11 portions, each being $2\frac{1}{4}''$ broad. There is, accordingly, a small wastage of about an inch here. The machine for the sides of the drawers at the time of peeling, not only severs the sheets into three portions, each being about $8\frac{1}{2}''$ broad, but also scratches on each portion lines to mark off the places where the folding will afterwards be done when the drawers are finally made. Similarly, the machines for the box-covers at the time of peeling not only sever the sheets into five strips, each of 5″ width, but also scratch on each strip the places for the subsequent folding.

5. From the peeling or veneering machines, the strips are then taken to the cutting or slicing machines. Here they are placed tightly packed one over another into a chamber about 7″ to 10″ high. Each of these machines has a kind of sharp guillotine knife fixed in a frame, which works up and down rapidly. As it goes sliding up and down, the compressed bundle of veneer strips is forced out to the required distance and is neatly sliced off. For the splints this distance is minute and is just enough to get them cut square; for the bottoms of the drawers it is 1″, for the sides of drawers $\frac{5}{8}''$, and for the box-covers $2\frac{1}{4}''$. In the case of splints, the cutting machine has also attached to the inner side of the guillotine knife, and placed at right angles to it, five minute knives situated at equal distances apart from one another. At the same time, therefore, as the former slices through the compressed bundle of veneer sheets, the latter neatly sever the cut portions

into six rows of splints about 2" long. It is believed that this machine needs the most careful attention, for if it is not adjusted properly, the splints will not be cut square. To give an idea of how fast these machines work, if we take the sheet for the splints as $\frac{1}{12}$ of an inch thick, and the space in the chamber into which the sheets are compressed as 7", it will be seen that about 84 sheets are worked on at a time by the slicing machine. The little knives mentioned above divide these into six portions for the splints. Therefore each time the guillotine works 84 × 6 = 504 splints are cut. The time taken by the knife to go up and down was not more than 4 seconds. So that in one minute one machine cuts about 504 × 15 = 7,560 splints.

6. These splints are then gathered up in baskets and taken to the drying rooms. Here they are placed in huge cylindrical drums (7' long × 3' 8" diameter) with perforated walls. These are then railed into chambers heated by steam pipes, and during the heating, they are slowly revolved round and round. This is done for five hours, and it is said that by the end of that time the splints are thoroughly dried, cleaned and polished. From this drying chamber they are then taken and placed into a sorting machine, which, by a shaking movement through a gauged sieve, rejects the broken bits. The splints are then neatly arranged in iron trays 20" × 14" × 2" and taken to the machines which provide them with their head composition.

7. There are five such continuous machines, and the ingenuity of their mechanism is absolutely bewildering and wonderful. The splints are gathered directly from the iron trays into a receptacle in the middle of the front of each of the machines. By a shaking movement, the splints are passed breadthwise from the said receptacle into the grooves of a sort of grill below it The front ends of the splints lying in the grooves project a little over the edge of the table, and whilst a pressure rail at the rear comes into play pressing against their other ends, the grill makes a forward movement and feeds the splints into the holes of a large metal conveyor-platform, which keeps slowly moving. The end of each splint is thus firmly fixed in a hole in this platform, and

as these holes are spaced apart a short distance from one another, the splints cannot touch each other. At first the splints stick out under the conveyor-platform, and in this position are transferred slowly by the moving platform over a heating arrangement to the paraffining apparatus, and then through the chocolate-coloured dipping solution. At the last named, each splint is furnished with its little spherical head, which is made of some igniting mixture, the chief ingredient of which is chlorate of potash. After this, the conveyor-platform passes round a drum, 42" in diameter situated at the rear of the machine. The treated splints are thus brought automatically on the upper side of the platform, which now looks like a gargantuan pin-cushion. In this position they are acted upon very efficaciously by a propeller fan, which, revolving over them at an enormous speed, helps to dry them. Continuing thus, the splints on the conveyor-platform arrive at the upper part of the machine and pass through a channel through which a second fan blows a blast of air, so that a complete drying of their heads is effected. The conveyor-platform then turns downwards once more near the front of the machine, and carries the finished and dried matches in front of the discharging apparatus, which pushes them out into a leather receptacle, from which they are carried to the machine which fills them into the boxes.

8. In the meantime in another apartment, the drawers and the box-covers are being made. For the construction of the former, the bottom and side pieces obtained direct from the slicing machines mentioned above are used, each kind being packed one over another in these drawer-making machines. The bottom pieces are put on a moving horizontal platform and the side ones on a vertical descending one inside a tube. Inside a brass funnel near by the latter is the paste, and on the left of the machine, wrapped up in a roll like a cinema film, is the blue paper cut to the required width. As the machines work, with clock work precision, the drawers are shot out from below beautifully and completely made. The newer kind of machines can make 50 drawers in a minute. In a similar machine the box-covers are made, 50 to the minute. All the above machines are worked by

young Burmese girls, who have become thoroughly *au fait* in their manipulation. To see these drawers and box-covers being ejected so well and completely made, reminds one forcibly of the legendary machine where the pigs go in at one end and ready-made sausages and pig skin boots come out at the other.

9. The constructed drawers and boxes are then put on a large moving platform, which carries them to a chamber where they are dried for half an hour, and then conveyed to the filling machines. In each of these machines the box-covers are put in one tube, the finished splints in another and the drawers on a moving horizontal platform. The machines do the rest, and not only fill the requisite number of splints into each drawer, and push the filled drawer into a cover, but also by means of a pair of revolving circular brushes smear the two sides of the filled box with the dark-coloured substance for striking the matches on, the chief constitutent of which is, it is believed, phosphorus. These filled boxes are then dried for a short time in a steam-heated chamber, after which they are carried to the machines which fasten the different kinds of labels on them. After this they are again dried for a short time, and are then taken to the last machines of all, which, not only make the familiar paper packets of ten boxes each, but also stick on labels to each packet. It is believed that the output of each of these packing machines is 50 packets to the minute. The finished packets are then steam-dried as before and then packed for exportation. 120 packets are put into each tin case and six tin cases are put in each wooden box.

10. It will thus be seen that the whole of the manufacture of matches in Messrs. Lim Soo Hean & Co.'s factory is done by machinery. This machinery, it was noticed, was supplied by A. Roller & Co., of Berlin, and to give the devil his due, to the inexperienced eye of the writer, it seemed to be extremely efficient and ingenious It appears that a German engineer erected and managed at the beginning the machinery, and a German chemist worked out the formulæ for the different igniting and striking compositions for Messrs. Lim Soo Hean & Co. But since the

advent of the war, or possibly even before that time, the whole factory has been efficiently managed by a Burmese gentleman. The entire business speaks very well for the enterprise and business acumen of Messrs. Lim Soo Hean & Co. It is up to the general public, therefore, to give not only this firm, but also the other match-manufacturing firm in Mandalay, every encouragement by using their matches in preference to imported ones. If memory serves the writer right, the Viceroy, Lord Chelmsford, on his departure from Burma, took with him several cases of these locally made matches, and our late Lieutenant-Governor, Sir Harcourt Butler, ordered that these matches only should be used in Government House. It is also up to the Forest Department to give these firms all the help and advice they need. Both Letpan and Shawbyu flourish in places where no very valuable species can be grown. Also, both these species are soft wooded and quick growing. It will, therefore, be a moot question when funds and personnel permit, whether it will not be feasible to have plantations made of these two species and work them on short rotations.

BIG TEAK IN BURMA.

BY C. G. ROGERS, I.F.S.

The Mehaw Reserve in the Pyinmana Division of Upper Burma has always been noted for its big trees. The reserve lies on the outlying foot-hills of the Shan plateau to the east of the Sittang. Owing to the steepness of its slopes and the unsuitability of its streams for floating purposes, very little extraction has been done in the past, and it is only lately as the result of girdling operations that much work has been done there.

The underlying rock is nearly everywhere a granite, which has been for the most part subjected to a severe dynamic metamorphism. The resultant gneisses are of various colours and much of the rock is porphyritic. These rocks are capped in the east of the area (chiefly) with laterites of recent origin. Where laterite is absent the soil is a rich, though shallow, sandy loam.

The rainfall is about 65 inches. There is much bamboo, and the general character of the growth is moist deciduous hill forest with a tendency to evergreen in the valleys and on the hill tops. Seedling and sapling teak are in great deficit and the largest class is over-represented, and the trees are probably too old to bear fertile seed. The regeneration of the area is, therefore, a problem which is still unsolved. Fire-protection has not yet been introduced, and the naturally heavy shade is probably responsible for the poor reproduction.

The available staff and money are all absorbed by equally rich but more accessible forests elsewhere, so there is no present likelihood of any artificial interference being possible.

The working-plan spreads the removal of the surplus over mature trees over two felling rotations of 20 years each, 37 years being estimated as the time required for trees to pass up from a girth of 6′ to 7′. Nominally, the girth limit for girdling is 7′; but, in practice, this has been in many compartments 12′, to avoid excess girdling. Consequently, the girdling officer notes for compartment 11, for instance, that 40 trees have girths between 14′ and 20′ and that the average estimated content of these trees was 10 tons each.

Messrs. the Bombay Burma Trading Corporation, Limited, have commenced felling the girdlings of 1910-11 and the late Mr. Cook, of that firm, has kindly given the logging results for five trees which he considers exceptional.

These are as follows :—

RECORD TREES.

Mehaw Reserve. Pyinmana Division.

Compartment 12—

	Length.	Girth.	C. feet.	*Total.*	
1	28	13′ 6″	318·9	=861·9	17 tons.
	28	12′ 5″	269·7		
	24	8′ 9″	114·8		
	22	6′ 5″	56·6		
	33	6′ 7″	89·4		
	18	3′ 4″	12·5		
2	23	13′ 6″	262·2	=662·7	13¼ tons.
	33	12′ 5″	317·9		
	22	7′ 9″	82·6		

Photo. Mechl.-Dept., Thomason College, Roorkee. Photo by C. G. Rogers.

Gamon Forest Reserve, Pegu Yomas Zigôn Forest Division. Compartment No. 34.
A flat alluvial soil near bed of stream. Altitude 500 feet above sea-level.
Teak tree, height 153 feet (taken with Abney's level), girth at breast-height 15 feet 10 inches.
Photographed 28th February, 1911.

	Length.		Girth.	C. feet.	Total.	
3	32 ...	...	13′ 6″	364·8	=737·1	14⅜ tons.
	37 ...	...	12′ 4″	351·0		
	12 ...	...	5′ 4″	21·3		
4	30 ...	...	11′ 3″	237·0	=531·1	10½ tons.
	31 ...	...	10′ 2″	200·3		
	25 ...	...	7′ 9″	93·8		
	Compartment 25—					
5	14 ...	...	18′ 0″	280·0	=686·8	13½ tons.
	14 ...	...	12′ 0″	126·0		
	27 ...	...	11′ 0″	204·0		
	17 ...	...	8′ 6″	76·8		

These splendid trees grow on the rich soil at the foot of the slopes—soil, which though level, is still well drained. It should be added that these enormous logs are being carted out on the ordinary buffalo-cart used for timber extraction.

The photograph accompanying this article (Plate 29) is that of a large teak tree growing on flat alluvial soil, near the bed of stream, at an altitude of about 500 feet above the sea, in compartment 34 of the Gamon Forest Reserve, on the Western slope of the Pegu Yomas in the Zigôn Forest Division. It shows that equally fine trees grow in other parts of Burma. The height of the tree measured with an Abney's level was 153 feet and the girth at breast-height 15 feet 10 inches.

The stump to the right of the tree is that of a teak tree, nearer the camera, of about the same size.

The photograph is an enlargement from a negative taken by the late Mr. E. V. Ellis, Deputy Conservator of Forests, Burma list.

IMPORTS OF JARRAH TIMBER INTO BRITISH INDIA DURING THE YEARS 1912-13 TO 1916-17.

Our readers are requested to refer to the article bearing the above heading on page 229 of the *Indian Forester* for May 1918.

On enquiry we find that during the quinquennium in question a large number of Jarrah wood sleepers were imported into British India. These sleepers, it now appears, were not included in the figures for imports of Jarrah wood into India obtained from the Director of Statistics, having been classified as "Materials for Construction-Sleepers" under Railway Plant and Rolling-stock—

vide Annual Statement of the Sea-borne Trade of British India issued under the authority of the Government of India. This explains the apparent discrepancy pointed out by Messrs. Millar's Timber and Trading Company, Limited, Bombay.

NOTE ON THE DYING BACK OF SAL SEEDLINGS.

BY E. A. SMYTHIES, I.F.S.

I have never seen any figures published which showed the proportion of Sal seedlings which die back, the period when they die back, and the effect of light and shade on their dying back. The following notes on a small experiment I carried out this year to try and throw some light on these points may be of interest :—

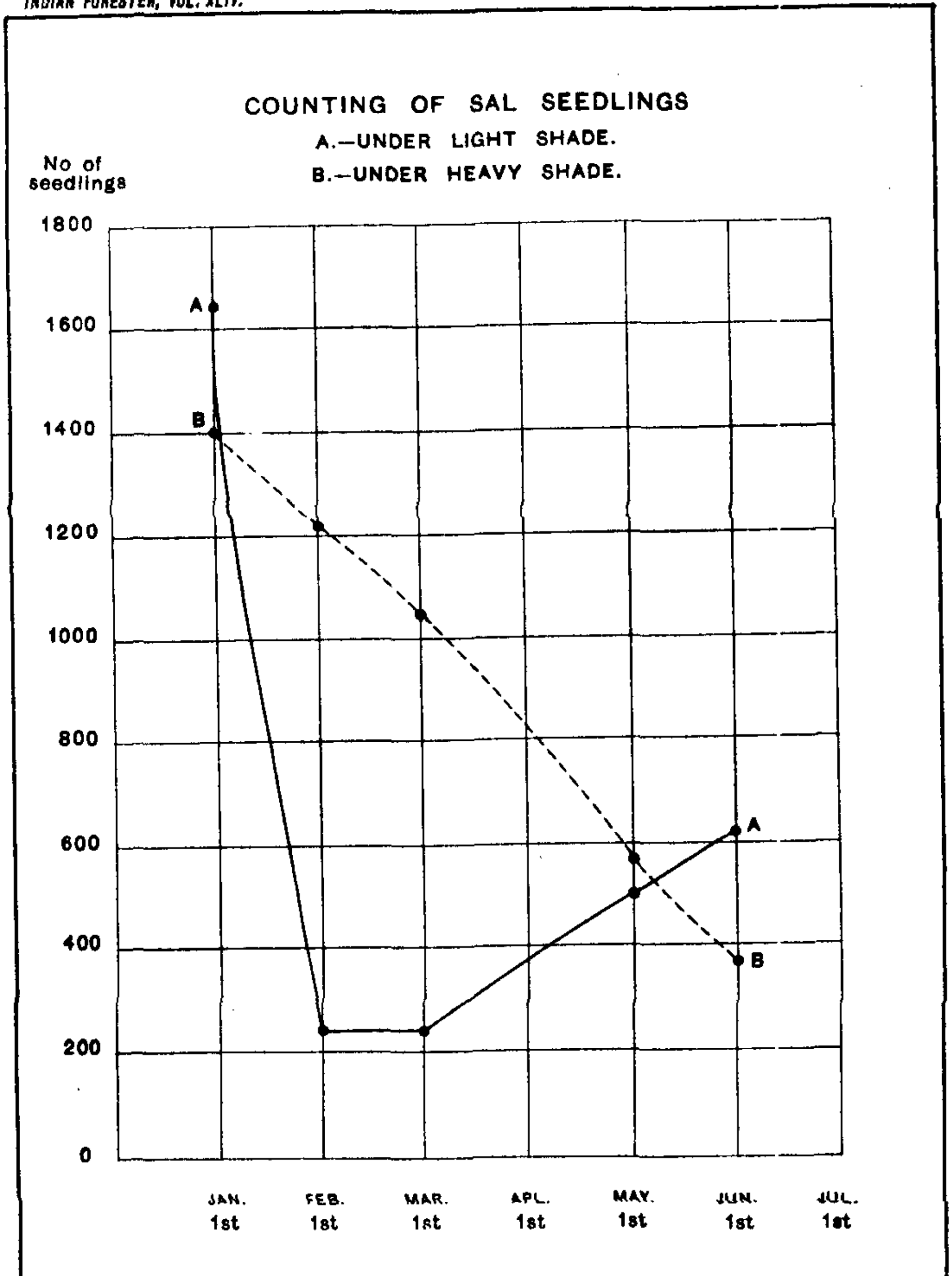
Type of Forest.—Pure Sal of good quality, very well stocked with poles and mature trees. Fairly dense undergrowth Sal reproduction established in groups here and there, where overwood was not too dense. One-year-old seedlings everywhere, the result of a good seed year in 1917.

Soil.—Elevated river gravels (upper Siwalik conglomerate) giving a porous rather dry soil, but excellent for Sal.

Slope and Aspect.—A plateau sloping very gently south. Two acres were selected side by side—1 acre (A) had all growth cut flush with the ground, except about 6 or 8 Sal standards left to give a very light overhead shade—1 acre (B) had no felling at all and seedlings were left in the dense shade of overwood plus undergrowth. In the middle of each acre (A) and (B), a patch of 10 yards square (900 sq. ft.) was demarcated and the seedlings counted periodically. The following interesting results were obtained :—

Date of counting.	No. of seedlings. A	No. of seedlings. B	Weather conditions.
1st January 1918 ...	1,654	1,400	January—Rainless. No frost.
February 1918 ...	257	1,220	February— Ditto.
March 1918 ...	252	1,040	March—Good showers on 20th and 25th. Hot.
May 1918 ...	504	550	April—Several good showers between 1st and 15th.
June 1918 ...	603	369	May—Rain on 18th. Hot.

NOTE.—The heavy felling in (A) was done early in January.


COUNTING OF SAL SEEDLINGS
A.—UNDER LIGHT SHADE.
B.—UNDER HEAVY SHADE.
No of seedlings
1800
1600
1400
1200
1000
800
600
400
200
0
A
B
A
B
JAN. 1st
FEB. 1st
MAR. 1st
APL. 1st
MAY. 1st
JUN. 1st
JUL. 1st

No. 2555.

I have put these figures graphically in the attached curves (Plate 30) and they show most clearly the very marked effect a heavy winter felling has on one-year-old Sal seedlings. These figures and curves indicate—

(1) that under heavy shade, Sal seedlings continue to die back very regularly all through the cold weather and hot weather. In this case 75 per cent have died back, or rather more than this, as the number 369 includes a certain number of seedlings which have died back and since shot up again ;

(2) that a heavy clearance and removal of shade causes those seedlings, which are going to die back, to do so *immediately*. In this case, to the extent of 85 per cent.;

(3) that at the beginning of the hot weather many of the seedlings which have died back in the felled area shoot up again and persist through the hot weather. (It should be noted that weather conditions were very favourable, with excellent rain in April and again in May.)

This effect does not occur in the shaded area to anything like the same extent.

What conclusions can we draw from these three established facts ? Obviously, we can draw no sweeping generalizations from one small experiment carried out in one favourable locality for a favourable half year. But we can, I think, say that these figures do suggest that a heavy and almost complete clearance is not bad even for one-year-old seedlings in favourable localities. This is not the recognized principle for Sal. We know that *established* Sal reproduction, 4′ or 5′ high, can be clear, felled over to its great advantage (barring, of course, frost localities), but Sal seedlings are usually kept in shade until they have established themselves, a period which may take anything from 5 to 20 years or more. By the beginning of March, I had come to the conclusion that a heavy felling was fatal to Sal seedlings and never imagined that my (A) and (B) curves would cross each other again.

It looks as if the dying back of Sal seedlings is really no set-back at all, but rather an advantage, and the following observation supports this contention. Several individual seedlings have been numbered, measured and noted on.

It has been found that those seedlings which have not died back have, on the whole up to 1st June, shown no sign of growth this year. Presumably the root-system could only cope with the transpiration from the two original opposite leaves, and had nothing to spare for fresh growth. Many of the seedlings which had died back, on the other hand, have already thrown up new healthy shoots to equal the last year's growth which they lost. If from this we may argue that the early dying back of seedlings is not a disadvantage, but enables them to start growth earlier, under the stimulus of light, we have again an indication that heavy winter fellings for the development of Sal seedlings may be advantageous. But, as I have already said, no final conclusions can safely be drawn from this one little experiment, but possibly more extensive observations and research on these lines might give us some interesting results.

GOVERNMENT OFFICERS, BURMA.

The following is a list of the Local Government's officers who have been set free, or are in course of being set free, for military service since the man-power resolution of the 14th May was passed :—

FOREST DEPARTMENT.

F. W. Collings, Deputy Conservator of Forests; A. H. M. Barrington, Deputy Conservator of Forests; A. P. Davis, Deputy Conservator of Forests; J. B. Mercer Adam, Deputy Conservator of Forests; C. K. Hargreaves, Deputy Conservator of Forests; G. S. Shirley, Deputy Conservator of Forests; E. W. Carroll, Assistant Conservator of Forests; A. E. Eden, Assistant Conservator of Forests; D. A. Allan, Extra-Deputy Conservator of Forests; F. W. Wright, Extra-Assistant Conservator of Forests; C. E. Parkinson, Extra-Assistant Conservator of Forests; F. G. Edwards, Probationary Extra-Assistant Conservator of Forests; G. P. Walden, Probationary Extra-Assistant Conservator of Forests. —[*Rangoon Gazette.*]

EXTRACTS.

PRODUCTION OF WOOD TAR IN INDIA.

A large import of tar from Sweden into this country has now been practically cut off, and to replace this trade with a local commodity, numerous experiments have been carried out at the various forest centres where tar-bearing timbers are extant. Wood tars are divided into two heads, *viz.*, wood tar and Stockholm or pine tar. Stockholm or pine tar is essentially a very cheap varnish consisting of resin, turpentine, and tarry oils. It is obtained by burning resinous pine in various forms of kilns with special bottoms to drain off the tar from the wood which is being carbonized. The wood is cut into small pieces and stacked in layers. The fire is inside the kiln and kindled at the bottom.

In spreading upwards the vapours escape at the top and flowing down the sides escape by collecting in the special bottom from which it is tapped. Various types of kilns are still in the experimental state, and a disadvantage of the pines in India is that they are not so highly resinous as the European pine. The result is that the tar distilled is proportionately more expensive than the European product.—[*Indian Engineering.*]

[NOTE.—We are unable to endorse our contemporary's statement that Indian pine wood is not so resinous as the European pine. *Pinus longifolia*, the long-leafed pine of the Himalayas, which is the almost exclusive source of Indian pine resin, is very rich in resin, especially trees which have been tapped for resin. The wood of such trees, especially stump wood, which is very largely used, is frequently saturated with resin, so much so that this wood is heavier than water.—HON. ED.]

Extracts from Agenda of the fifteenth meeting of the Board of Industries held at Cawnpore on the 25th April 1918.

The Board noted with appreciation that Government has been pleased to sanction a grant of Rs. 10,000 for experiments in tannin and other dye extracts, and a loan of Rs 30,000 to Mr. A. H. Mirza, Proprietor of the Ramnagar Cutch Factory.

The Board was pleased to note that the Government of India have authorized the Local Government for the provision of 1st class tickets to all State scholars during the period of war, for the journey from Marseilles to London as long as the conditions of travelling in France render it necessary. It was also noted that facilities are procurable in the United Kingdom for the study of wood distillation.

THE TREATMENT OF TIMBER.

I.

The silence of the Forest must have fallen on the officers of the Forest Department to have kept them for six years from making public the extensive work that has been quietly carried on since 1912 in connection with the antiseptic treatment of sleepers. But it has been better so, better now to take up their record of a few really fruitful years of work and to learn that what has been so

long only hopeful speculation has been worked up into solid realization, that no doubt whatever now exists as to India possessing a long list of forest trees which can easily be called upon to supply for many years to come all the sleepers she needs for her railways if only the railways themselves will rise to their responsibilities and take out of the hands of the overburdened Forest Department that part of the business which, after all, most concerns themselves. We used to be astonished when we saw in American journals the long lists of timbers on which railways in the United States and Canada relied for their timber supplies and often asked ourselves what was wrong with our 250,000 square miles of Indian forests that they were not producing more than half a dozen kinds of sleepers while the cry constantly rang that these kinds were already being exhausted and we must go outside India for our supplies or turn to metal, and ferro-concrete sleepers. Looking at Mr. Pearson's note in the Indian Forest Records, it is quite a relief to find that after all there was nothing wrong with the forests, that the timbers were there and only wanted some one to come and find out. Mr. Pearson has done this. His farther note on the "Antiseptic Treatment of Timber, recording results obtained from past experiments" is so replete with information that on reviewing it there is a difficulty in finding the point at which one should begin. We have deliberated and concluded that we had better first turn to page 97, Part VI, which deals with factors governing the treatment of sleepers. Obviously, these demand first consideration since even the fool might ask—why treat a sleeper at all before you know it is worth while? Let us then see what some of these factors are.

First then, Mr. Pearson brings up to date the list of Indian timbers that he has ascertained to be suitable for railway sleepers after treatment. To our astonishment this list extends to 32 species. It is divided into three classes, *viz.*, Class I, comprising timbers which are most likely to fulfil the necessary requirement; Class II, comprising the next most likely species to fulfil the necessary requirement; Class III, possible sleeper woods. In Class I there are twelve species, in Class II ten species, in Class

III eleven species; and in each class there might very well be more but for the fact that the absent species are in such demand for other purposes as to make their available quantity and price prohibitive for sleeper purposes. All the sleepers in all three classes answer the demands that govern suitability for sleeper use which are—(1) that the available supply should be large, (2) that the cost of the timber and a suitable treating plant be not excessive, (3) that the timber be of sufficient strength for the purpose, and (4) that it should yield readily to treatment. As regards mechancial strength, some of these timbers will not stand use as sleepers without bearing plates, as, for instance, *Pinus longifolia* (chir), *Pinus excelsa* (kail), *Abies pindrow* (silver fir), *Picea morinda* (spruce), and some others. Silver fir and spruce, it may be remarked, are much the same as Douglas fir in character and the latter is a most popular sleeper timber in America. There are others, however, which are hard timbers requiring no bearing plates, such as *Terminalia tomentosa* (sain), *Terminalia myriocarpa* (hollock), *Terminalia manii* (Andaman timber), and others. The capacity for holding the dog-spikes is also an important consideration; and with regard to this the note says—"The spikes were found to be holding moderately well in the case of the pine sleepers, well in the case of the Dipterocarps, while the *Terminalia tomentosa* sleepers held the spikes so strongly that they could only be removed with difficulty." The power of some of these timbers to resist the withdrawal of spikes has been mechanically tested at Dehra Dun, giving the following results:—Deodar, from 3,000 lbs to 4,000 lbs.; Sal from 4,000 to 5,000 lbs.; Chir, 3,000 lbs; *Dipterocarpus alatus* (kanyin), 6,000 lbs. to 8,000 lbs.; *Dipterocarpus tuberculatus* (in), from 7,000 lbs. to 8,000 lbs.; *Dipterocarpus pilosus* (hollong), from 5,000 lbs. to 7,000 lbs.; silver fir, 2,000 lbs.; spruce, 2,500 lbs.

We now come to the important subject of seasoning, and, remembering the laxity with which this factor in timber operations is dealt with, too much attention cannot be drawn to the words of Mr. Pearson—"It is difficult to lay sufficient stress on the importance of seasoning timber before treatment, for unless proper care is taken in this respect any undertaking of this nature will be

doomed to failure." If unseasoned, the moisture left in the timber impregnates the fibres and causes decay, it also promotes the growth of fungus and invites attack by insects. The timber is in a condition liable to develop bad cracks and the juices in it resist the entry of antiseptics; in fact, such timber, if treated, will be found on opening out to contain the oil only in irregular patches and streaks. The timber ought to be what is known as "air dry" before treatment, but as the percentage of moisture constituting this condition varies very largely according to locality, the general rule Mr. Pearson lays down is that in dry, hot localities the moisture content should not exceed 15 per cent. and in wet localities 25 per cent. In the dry parts of India seasoning is effected very rapidly but there is the risk of timber cracking badly in seasoning unless protected from the direct rays of the sun. In wet localities it is difficult to reduce moisture to below 25 per cent. by natural seasoning, except for a short period in the hot weather. Artificial seasoning is effected either by steam or oil. In steam seasoning the timber has to be exposed to live damp steam for some hours in a cylinder in which the temperature is raised to about 250° F. and the pressure to about 20 lbs.; then a vacuum of about 20 inches of mercury is applied for an hour or so which extracts a proportion of the moisture both water and sap. In oil seasoning the sleepers are placed in a cylinder together with hot oil and the temperature raised to, say, 230° F., moisture escapes to the top of the cylinder and distills over, and when this has gone on for some hours, heating is suspended, the cylinder filled to the top with oil and a pressure of about 15 lbs. applied for 15 minutes. In this way the sleepers lose a certain amount of sap and absorb a certain amount of oil. But both these operations effect only partial seasoning, though the second gives somewhat better results than the first. Mr. Pearson is of opinion that it is best in wet localities to effect natural seasoning at first as far as it will go and then finish the process in drying kilns.

Of the two processes employed in treatment—open tank and pressure plant—the latter gives the better results. There are, of course, a great many antiseptics for choice and several have been

tried in the Forest Department experiments. Of four—green oil, Avenarius carbolineum, solignum and a liquid fuel—and a fifth composed of definite proportions of the second and fourth, green oil, which is a commercial coal-tar creosote, seems to give the best results in India. There is, of course, the possibility of mixing coal-tar creosote with a petroleum product for the sake of economy, but no general experiment seems to have been made so far with such a mixture. The functions of mineral oils are to distribute the more toxic oils to act as a water-proofing agent to the timber and to either reduce the cost of treatment or to allow of more oil being injected into the timber. Salt solutions, such as chloride of zinc and copper sulphate, have been experimented with in India only in the laboratory; they are not in favour as they are liable to leak out during heavy monsoon rains in this country. Then there are mixed impregnations first with a salt and then with an oil, or with the two combined. The cost of such treatment is small but has not the same merit as treatment with a creosote alone. It is necessary only in certain cases to treat sleepers to refusal, and as to the number of pounds of oil to be given per cubic foot, that depends on the mechanical life of the particular timber, since it is of no use to preserve the timber against decay beyond the point at which it is no longer mechanically fit for duty. For example, *Pinus longifolia* sleepers need impregnation with no more than 5 lbs. per cubic foot, the *Dipterocarp* sleepers with from 7 to 8 lbs., while *Terminalia tomentosa* sleepers should be treated to refusal. Accordingly, open tanks can generally be used if the amount of absorption does not exceed 4 to 5 lbs. per cubic foot and the number of sleepers to be treated does not exceed 30,000 to 50,000; but for heavier impregnation or where larger numbers of sleepers are involved, pressure plants should be employed. We extract from the note the following useful table showing the estimated cost of treating sleepers based on the Forest Department experiments :—

Species.	Locality from whence procured.	Powellized Sleepers.	Avenarius carbolineum.	Chloride of Zinc and Green Oil.	Solignum and Liquid Fuel Oil.
		Rs. a. p.	Rs. a. p.	Rs a. p.	Rs. a. p.
Pinus longifolia ...	Chakrata Divn., U. P.	1 1 0 Per B G sleeper.	0 12 4 Per B. G. sleeper.	1 1 4 Per B G. sleeper.	1 5 0 Per B. G. sleeper.
„ *excelsa*	Do.	Do.	Do.	Do.	...
Dipterocarpus tuberculatus...	Upper Burma ...	1 3 0 B. G.	0 7 3 M. G.	0 9 0 M. G.	0 14 10 M. G.
„ *alatus* ...	Do.	Do.	Do.	Do.	Do.
Terminalia tomentosa ...	Bombay and Central Provinces.	1 3 3 B. G.	0 9 5 M. G.	1 0 2 B. G.	1 3 8 B. G.

Where solignum and liquid fuel oil were used mixed together two mixtures were tried, first 40 per cent. solignum and 60 per cent. liquid fuel, and, second 33 per cent. and 67 per cent. respectively. Mr. Pearson is of opinion that a good grade of creosote mixed with a cheap petroleum oil would reduce cost considerably. This procedure has been adopted in treating the U. P. chir sleepers, though, in this instance, the amount of oil to be absorbed per sleeper has been raised to 15 lbs., involving a corresponding rise in the cost of treatment. Mr. Pearson also thinks that any treatment which involves a maximum cost of more than Re. 1-4-0 to Re. 1-6-0 per B. G. sleeper is of doubtful practical use. Cheap creosote of good quality is at the basis of the whole question, and so long as India has to import all it wants so long will the treatment of sleepers be handicapped. As to this we are informed that a Calcutta firm is now actually considering the question of manufacturing coal-tar creosote; as a matter of fact, it has been produced, but the firm is engaged upon improving the quality so as to bring it up to specification. There exist no reasons why success should not be achieved.

THE TREATMENT OF TIMBER.

II.

Laboratory experiments in treatment were commenced in 1909 and continued up to 1914, the majority of the specimens having been laid down between 1909 and 1911. The specimens measured 18" × 2" × 2", there were 12 species of timber, and 23 antiseptic solutions comprising both salts and oils employed, and the period of immersion, when possible, was kept constant. After treatment in the laboratory, the specimens together with untreated specimens were put into the ground together in a place known to be infested with white-ants. In the case of the Powellized specimens, after being from 6 to 7 years in the ground, it was found that 50 per cent. of those treated as against 32 per cent. of the untreated specimens remained serviceable; in other words, the average life of the treated specimens proved to be 5 years 2 months and that of the untreated specimens 3 years 7 months. The absolute results do not show up well, but the fact has to be taken into account that timbers of varying kinds were taken from the hardest to the softest and these are the average results. The second group of laboratory experiments was made with Avenarius carbolineum, coal-tar, jodelite, solignum, tar from *Pinus excelsa* and green oil. Ordinary coal-tar and tar from *Pinus excelsa* gave practically the same results, showing an average durability of 3 years 9 months and 3 years 11 months, respectively. The other four antiseptics all gave better results—Avenarius carbolineum 5 years 2 months, jodelite 5 years 4 months, solignum 5 years 7 months, green oil 5 years 8 months All four are coal-tar creosote preparations and green oil stands first. The average life of the untreated specimens varied from 2 years 8 months to 3 years and 3 months. The third group of laboratory experiments was with créosyl, anthrol, Burma oil and liquid fuel from Borneo ; the two first being coal-tar products, the two second petroleum products. The average durability in years of the specimens in the order named was, respectively, 5 years 2 months, 5 years, 3 years 4 months, 3 years 4 months. The average durability,

in years, of the untreated specimens was 2 years, 2 years, 2 years, 1 year respectively. The fourth group of laboratory experiments was with certain salts—atlas solution, Béllit, sodium fluoride and chloride of zinc, and Hylinit. The general results are inferior to those obtained with oils, primarily due to leaching out of the salts. The average durability in years of the specimens in the order named was, respectively, 4 years 6 months, 3 years 4 months, 4 years 5 months, 3 years 9 months. The average durability in years of the untreated specimens was 2 years 10 months, 2 years 6 months, 2 years 7 months, 2 years 11 months, respectively. The fifth group of laboratory experiments was with anticide, MacDougall's insecticide, mort-ant, and Burnettizine. As these experiments, however, cover a period of only from 2 to 4½ years the result cannot be said to be final. The results are quite satisfactory in the case of anticide—4 years 1 month as against 1 year 3 months for untreated specimens; 9 out of 11 specimens treated with MacDougall's insecticide remain after 3 years and 8 months as against 2 untreated specimens. Taking into consideration that of the 9 treated specimens remaining, 5 are for all intents and purposes sound, the results are fairly satisfactory. Mort-ant has given less favourable results than either of the two previous solutions; 5 remain sound out of 11 treated specimens after 3 years and 9 months, while the durability of the treated and untreated specimens is practically the same. The Burnettizine experiment has only been in progress two years, so no definite conclusion can be drawn; the fact that out of 12 treated specimens, 4 have had to be removed, and that 4 others are already seriously damaged, does not hold out any great hopes that their solution will prove to be suitable when employed under Indian conditions. The sixth group of experiments was with crésol-calcium, aczol and barol; all of them antiseptics composed of salts and oils, mixed to form emulsions. Results from crésol-calcium and aczol were extremely poor, but those from barol were promising. Reviewing results of all six groups of laboratory experiments it may be stated generally that the hard and moderately hard woods treated, as compared with untreated specimens, have fared in proportion better than

the soft woods. The results obtained with Powellized timber are fairly satisfactory, but the outstanding feature of the experiments is the superior results obtained with the various coal-tar-creosote products as compared with salt solutions. It is only just possible that salt solutions might answer in very dry localities like Sind and parts of the Punjab, but this remains to be proved.

Having dealt with Mr. Pearson's laboratory experiments we now proceed to his field experiments. The primary object of the first was to test the value of certain selected antiseptics, that of the second to test durability of treated sleepers under practical conditions. First we have the Powellizing process. This consists in immersing the timber in a saccharine solution containing small quantities of arsenic gradually heated up to a fairly high temperature, the time of immersion depending on the density and size of the timber. After immersion the timber is thoroughly dried in a drying chamber. Next there is treatment with Avenarius carbolineum, a coal-tar creosote of good properties but priced in India at Rs. 2 a gallon, which made the cost prohibitive unless impregnation was limited to the use of from 5 to 7 lbs. only per broad gauge sleeper. Thirdly, we have chloride of zinc and green oil, a combination adopted for the sake of economy. It has been pointed out that salt antiseptics leach out in India and are therefore unsafe to use. In this combination the sleeper is first made to absorb as much of the salt as it can, then dried and plunged into a hot bath of the oil of which it is allowed to absorb only a small quantity. This has the effect of forming a thin shell of oil-impregnated tissue on the outside which prevents the salt from leaching out and at the same time prevents its contact with the rail foot which otherwise it would attack. The green oil costs only 13 annas a gallon in India and the whole cost of treating a B. G. sleeper is only 2½ annas. Fourthly, we have a mixture of solignum and Rangoon oil, a combination adopted for the sake of economy, as solignum is expensive. With the Powellizing process the complete cost of a B. G. sleeper handed over to the Railway comes to from Rs. 4-8-0 to Rs. 5-8-0 dependent on the species of timber. With Avenarius carbolineum the cost for a B. G. sleeper is from

Rs. 5-4-6 to Rs. 6-4-6, and the cost for a M. G. sleeper from Re. 1-9-2 to Rs. 2-5-5; but these latter figures are of little value because they exclude royalty and are based upon the use of only 1·1 lb. of oil per sleeper, which is wholly inadequate. As a matter of fact, the cost of adequate protection with Avenarius carbolineum alone is prohibitive and the oil would have to be mixed with some cheap solution, such as Burma oil. The cost of treatment with chloride of zinc and green oil is given as Rs. 4-9-4 per B. G. sleeper; with chloride of zinc and Avenarius carbolineum Rs. 3-0-7. The cost of *Pinus longifolia* sleepers treated with 40 per cent. solignum and 50 per cent. Burma oil is given as Rs. 4-14-0 per B. G. sleeper. The cost of *Dipterocarpus tuberculatus* sleepers treated with 33 and 66 per cent., respectively, of the same oils is given as Rs. 2-10-0 per metre-gauge sleeper.

Presuming that a rapid expansion of railways will take place in India as soon as money becomes plentiful again, this question of treating sleepers in the country on a large scale claims immediate attention. To treat and use the second quality timbers of the country means the development of both forests and railways, a very large sum of money will be kept in the country which unnecessarily goes out of it, and that portion of it that will go into the treasure chest of the Forest Department will go some way towards relieving it of its chronic impecuniosity. We have been fortunate so far in possessing certain sleeper timbers which it would be false economy to subject to treatment; but these have at last begun to fall short of the demand, and because we have not embarked on the policy of other countries and used preservatives to make other species durable enough for railway uses we have had to resort to metal sleepers or imported timber sleepers. The latter have not proved a success in India, obviously because they have been preserved for use in a wholly different climate. The former are only a fair substitute, but with a few exceptions engineers would prefer to have timber for the road. It is unreasonable therefore to allow a large variety of sleeper timber to rot in the forests when they are badly wanted and when it is now proved that they can be safely and economically used. The

exploitation of such timbers as Mr. Pearson has brought to notice will certainly bring down the price of sleepers and as certainly will it be found in time that there are still other timbers in our forests whose merits for sleeper duty only wait to be discovered. We cannot conclude without adding that we trust this further note on the antiseptic treatment of timber recording results obtained from past experiments will find its way into the hands of all railway engineers in India.—[*Indian Engineering.*]

A LUMBER CAMP IN THE HIGHLANDS.

NEWFOUNDLAND FORESTERS AT WORK.

CRAIG OF THE GOATS, PERTHSHIRE.

A century ago, John, fourth Duke of Atholl, resolved to plant the waste mountain sides of his estates with spruce and larch by the million. By the end of the century, said he, his descendants would reap a hundredfold what he had sown. The Napoleonic wars had taught Britain what scarcity of timber meant.

"My plantations," he declared, "will make up and probably be productive of an income to a much greater amount than that of any subject in the Kingdom." He said confidently that if one-fourth part of his larches arrived at maturity by the end of the century, they would supply "all the demands of Great Britain for war or commerce." He planted 15,573 acres, mainly of barren mountain side, with 27,431,600 young trees. Many other northern landowners followed his lead.

For long Duke John's expectations seemed likely to be falsified. Great storms blew down hundreds of thousands of trees. The price of timber fell. The wooden ship on which he had based his plans made way for the iron ship. As cheap rail and ocean transport developed, our timber merchants revelled in the loot of the vast virgin forests of Canada, the United States, and Scandinavia: British forests, like British farms, could no longer compete in their own home markets against this flood of foreign imports. Yet to-day his foresight is proving true. The great

forests of Scotland, utilized mainly during the last two generations as shooting preserves, have suddenly become an enormously valuable Imperial asset. Timber must be had in vast quantities for a hundred war purposes. We cannot import it. We must—now perforce—rely on the resources of our own island. Scotland is supplying more than its share. Men from the ends of the Empire are in the North to-day, clearing the hills, felling and despatching their giant trees with the expedition of a Western lumber camp. Most of them are not Westerners, however, but Easterners, men from Ontario, Quebec, New Brunswick, and Nova Scotia, together with hundreds of picked Newfoundland lumbermen, wearing khaki and serving under military discipline. To the North there has come a sturdy batch of New Englanders.

THE LUMBER CHUTE.

This is a Newfoundland camp on the Atholl estate. A few days ago the Duchess of Atholl, after entertaining a party of woodmen guests, confessed that while she was glad to see them, and hoped to see more of them, her heart was heavy at the disappearance of her beloved woods. One can understand her grief. Here, up on the Craigvinean, the Craig of Goats, as it is rightly called, 800 ft. above the sea-level, one gazes around upon what was one of the most beautiful wooded scenes in Scotland. In the immediate neighbourhood are grouped a succession of fallen giants—great, noble timber. Some distance below a lumber camp can be seen. Along the steep middle ridge of the hillside runs a temporary mountain railway, built with lightning speed to transport the logs to the point where the great chute, 1,400 ft. long, falls vertically, down which the thousands of great felled trunks—often more than half a ton in weight—slide thundering to the mill below. This mill has been completed in incredibly short time, and the whole place has an air of hustling resolution. The rough wooden huts of the men, and the simple, effective machinery, do not seem to belong to an old civilization like ours. Planted down here, one might imagine that you were in Newfoundland. In truth, Newfoundland has transferred its ways to the heart of Perthshire.

"These men work as though they are fighting against time," said an old Scottish factor somewhat resentfully, when he saw the Newfoundlanders set to. "We are," came the ready reply. "That is what we are here for, in war time." At first the Scotch woodsmen were inclined to feel sore at the unconventional methods of these newcomers, and various big challenges were exchanged. The cutting down of trees is a solemn affair. It ought to be done with a certain stateliness. It ought above all to be done sparingly, and with a certain nicety according to estate traditions. That is the old British idea. But here are men doing it wholesale, leaving nothing behind.

It was necessary to find a means of carrying the great trees down from two high levels, 1,800 ft. in all. Experienced local men advised a mountain railway equipped with winding drum and steel cables, etc., which would have taken considerable time to construct, and would have cost something probably running into four figures. The Newfoundlanders laid a simple chute, consisting of a triple line of trunks of trees forming a kind of running trough. The total cost of this, apart from the timber, which they cut on the spot, was a few score of pounds. Down this simple line, built in a few days by the men themselves, with a sloping curve at the bottom to bring the monster logs easily to their place, the great trees now descend. They come to rest in the "Log Pond," which has been built by damming the little stream which adjoins the saw-mill in the meadow at the foot of the hill, and from thence are hoisted by the jack ladders into the mill.

How the Newfoundlanders Came.

How have the Newfoundlanders come to Perthshire? Lumbering on a large scale is comparatively a new thing in Newfoundland itself. The timber growths of the Tenth Island lay mostly unappreciated until, less than half a generation ago, the Anglo-Newfoundland Development Company started its work at Grand Falls. In the spring of this year, when signs of a timber famine threatened, Mr. Mayson Beeton, of the Anglo-Newfoundland Company, suggested to Sir Edward Morris, the Prime Minister of

Newfoundland, that a battalion of Newfoundland lumbermen might be organized for timber-cutting here. The suggestion came at the right moment, for on the previous day Mr. Long had written to Sir Edward Morris, asking for help of this kind. Mr. Beeton, with the Premier and the Director of Timber Supplies, at once went to Lord Derby. Within 24 hours the scheme for the Newfoundland Forestry Corps was arranged. Cables were set to work and recruiting had begun, the organization and direction of the Newfoundlanders being left in Mr. Beeton's hands.

The men now at work so far number about 300, to be increased very shortly, it is hoped, with fresh drafts coming along to about 1,000. The *personnel* of the corps is remarkable. The officers, including Major Sullivan, the O.C., are all of them practical lumbermen save perhaps the Adjutant whose business it is to maintain military administration and discipline. No man is accepted for the Forestry Corps unless he is unfit for fighting, or is well over his early manhood, married and with a family. One veteran of over 60, a general utility man, boasts of 40 years' experience in mills. Another has been nearly 50 years lumbering. There are boys in their mid-teens here, too young to go to France to fight, but determined to do something to help to win the war. On Sunday afternoons one sees the forestry men making friends with the country folk in every village around, looking in every way smart, good soldiers. And when their battalion marches into Dunkeld it is difficult to believe that these same well-set ranks are made up of backwoodsmen who have volunteered their service from the freest life in the world—the life of the woods.

They have received a warm Scots welcome from all—from duke to cottager. The country around the Craig of the Goats is as wildly beautiful as any Scotland has to show. The trees are magnificent. The lumber has been well cared for. The trees run straight and true and high. The axemen talk of some of the timber lovingly, as a connoisseur would talk of fine wine. There was one spruce tree whose main trunk was over 100 ft. long. It was 29 in. in diameter at the stump, and 15 in. in diameter 53 ft. high. They got 97 ft. of timber out of it. The woodsmen count

the rings on the trees to tell their years 90, 95, 100, 105 years old. Duke John planted well!

Even while the Newfoundlanders are cutting down great stretches of the most beautiful countryside large numbers of young Scots women are at work planting new districts afresh, for Scottish landowners realize that under the conditions likely to prevail in the world for some generations ahead their forests will be sources of essential national wealth.—[From a Correspondent in *The Times*.]

DOMESTIC OCCURRENCES

BIRTH.

CANNING.—At Hawkesdale, Naini Tal, on the 4th September 1918, the wife of F. Canning, I.F.S., of a daughter.

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PROGRESS OF SPIKE INVESTIGATION IN THE SOUTHERN CIRCLE, MADRAS PRESIDENCY, DURING 1917-18.

BY P. M. LUSHINGTON, I.F.S.

1. INFECTION *versus* UNBALANCED CIRCULATION OF SAP.

These two theories were fully put before the last Conference. Dr. Coleman, supported by his grafting experiments, by which he has shown that the disease can be produced in a healthy tree by infection from an unhealthy graft, is the champion of the infection theory. On the other hand, Mr. Hole somewhat startled the conference by his paper dealing with unbalanced sap circulation in which he claimed to have discovered the cause of spike. The theory was not altogether new, for a paper published by Mr. Whitehead in the *Indian Forester* for May 1916, suggested that "spike" was not a disease, but due to a reduction in the supply of water. Mr. Hole's Note is, therefore, rather an amplification of the same idea than a new theory. The observations, which have been

made in this Circle seem, at first sight, to be opposed to the theory of infection, for many instances of "isolated spike" were discovered in various districts as published in my Note in the *Indian Forester* for February 1916 but, as I shall show later, the bulk of observation made is in favour of infection.

It seems desirable, at the risk of repetition, to trace once again the history of spike, in this Circle, in the light of the further information which has been obtained.

Undoubtedly, the first case of spike was the solitary tree observed by Mr. McCarthy in the Javalagiri Reserve on the path to Nandimangalam in September 1913. Mr. McCarthy could not make out where this tree got the disease. There seems little doubt, however, that it came from Mysore, as the Mysore map published at the last Conference shows a large area "spiked" just south of Nandimangalam Jaghir. This is only five miles away from Mr. McCarthy's tree. Judging from a map in the Range Office, two more trees were discovered in October 1913 and removed. In the following year, further trees were discovered and preventive measures (the removal of all healthy trees within 100 yards of a spiked tree) were started. Ninety-two spiked trees were marked in July 1915 and the preventive measures were continued but very badly done. In December of that year, the spiked trees had not all been extracted though the healthy trees had been removed to a large extent. The disease continued to spread around this centre and in 1916 many more spiked trees were enumerated. By October 1917, the disease had made great progress in this locality and hundreds of trees had become spiked. The chief spread has been towards the North and North-East but there is also a spread to the South. How far it has gone has not been accurately determined, but some trees were found spiked on the cart-road from Tokanattam to the Nandimangalam road. It is roughly computed that 300 acres are now badly spiked, and another 300 acres are affected. In the badly spiked portion, practically every tree is spiked. Simultaneously with Mr. McCarthy's find, it was ascertained that an area of 30 acres at the North end of the Block, five miles away, was affected and the same remedial measures were adopted but

imperfectly carried out. Notwithstanding the wholesale removal of sound and spiked trees, spike has spread over this area to the extent of about 1,200 acres. During 1917 no less than 1,487 spiked and 252 dead trees were marked for removal.

In 1915 spike was discovered in the Thalli Reserve about 12 miles from the infected area at the North of Javalagiri and 20 miles South of an infected area in Mysore.

In 1915 also Mr. Wilson found two trees spiked in Tholuvabetta and one in Madeswarangudi about three miles away from Tholuvabetta. Both these localities are about 18 to 20 miles South-West of the spiked area in Javalagiri. The progress of spike has been far more rapid in Tholuvabetta and in 3½ years 62 trees have been found spiked in the observation area as against 22 in Madeswarangudi.

The fact that these isolated areas are found seems to favour the non-infection theory, whilst the way that the disease spreads is certainly in favour of infection.

More remarkable cases of isolation are those from the Kollimalais and Pachamalais. The report of spike in the Kollimalais (40 miles from the nearest known spike) was first made in 1915, and the disease was believed to be confined to an area of 120 acres with 78 spiked trees. Mr. Rama Rao showed that this was incorrect ; for, in this locality, the disease had spread whilst another locality had been attacked ten miles away. Subsequently, spike in considerable quantity was found about [illegible]5 miles away in the Pachamalais, a separate Range of Hills.

The most remarkable case of isolation discovered up to date has been the Javadi area, which is over 100 miles from any known spiked area, and in this case there is very definite information. Sixty-five spiked trees were found over an area of 11 acres. It is practically certain that every spiked tree in the locality was found as an area of 40 acres around it was cleared of all sandal.

These cases of isolation are of course strongly opposed to the infection theory, more especially as, in some cases, there are large stretches of cultivated lands, devoid of sandal, between the

infected areas. It has been suggested that the intervening areas should be searched, but this does not come within the region of practical politics, as anyone knows who has tried to push through 40 miles of lantana or other scrub to see if the trees were spiked.

2. THE KOMATTIVERI EXPERIMENTS (SOUTH VELLORE).

In February 1916, one tree and in August 1916 six more trees were trenched to a depth of 3 feet or more until very hard soil was reached. In this way, all the lateral roots which extended beyond 12 feet, were cut through. The platforms thus formed were cleaned and have been kept quite clear of vegetation from then up to the present time. Frequent inspection of these trees has been made not only by subordinates and District Forest Officer but by the Principal of the Forest College as well as the Conservator, and there is no doubt that they have been deprived of all chance of nourishment which could be taken up through the haustoria. The experiment is not yet complete, but as it has now continued for two years without the trees showing any signs of failure it certainly appears that sandal is not an obligate parasite.

Basing his argument on these experiments, coupled with the way that hundreds of trees torn out by the cyclone of November 1916, have been restored apparently without injury, Mr. Venkataramana Ayyar has compiled a very able article on the 23rd February 1918, which I trust will shortly be published in the *Indian Forester*. This article controverts Mr. Hole's dictum that spike is caused by unbalanced sap circulation and forms a valuable contribution to our knowledge of the sandal tree. Incidentally, the article shows that the sandal must be an exceedingly hardy tree, capable of repairing damage to its roots in a very short space of time.

3. THE ANDIAPPANUR EXPERIMENTS.

Four trees were operated upon on *4-9-1916* to see if anything like spike or stag-head could be produced either by poison or by deprivation of nourishment through the haustoria. They have been

carefully observed from time to time and have shown the following results :—

Tree No. 2.—All the surface roots were exposed on *4-9-1916* and the roots punctured at intervals with a nail and strong sulphuric acid poured in.

On *19-11-1917* the root-system of the tree was dug up and examined. The roots were bare of haustoria for a long length and the ends of root No. 3 found dead. Haustoria were found at the ends of three roots and another root was not traced out but, on this occasion, was severed. The remaining roots were again punctured at 6″ intervals and sulphuric acid poured in, by which the root-wood was at once scorched. No falling off in the vigour of the tree has been noticed up to July 1918.

Tree No. 4.—Treated in the same way as No. 2 on *4-9-1916.*

On *19-11-1917* four surface-roots were exposed and no further root-system was found within a foot of ground-level. There was an absence of rootlets, but haustoria were found at the end of the roots.

It was again treated in the same way as tree No. 2. No sign of failure has been noticed up to July 1918.

Tree No. 7.—This tree was treated on *4-9-1916* with sulphuric acid ; but, in addition, all the root-ends of the surface roots on one side were severed.

On *19-12-1916* some of the branches had somewhat sickly looking small yellowish young leaves, but by *6-3-1917* the tree had recovered and had a dense crown of dark green leaf.

On *18-11-1917* the new flush of leaf did not appear to be quite healthy and there were a few abnormal flower buds with persistent bracts.

On *19-11-1917* four main surface roots were uncovered and one root 18″ below ground. On roots 1 and 2 new rootlets with haustoria were developed from the parts cut in the preceding year. Root 3 had developed three rootlets from the cut portion but all had died. On root 4 dead bark was found on the injured portion cut last year but the wound had healed.

No further injurious development has occurred up to July 1918.

Tree No. 11.—On *4-9-1916 all* root connections were severed but no sulphuric acid was used.

On *19-12-1916* the tree was found to have some narrow yellow leaves on one side but had recovered by *6-3-1917*.

On *19-11-1917* the tree was found to have smaller leaves than the rest of the trees in the compound. Some of the leaves were in threes and there were a few abnormal flower buds.

The whole root-system was exposed between *19-11-1917* and *21-11-1917*. Old cuts were found on seven main roots but three main roots were found uncut. Sixteen old cuts were found and all had produced new rootlets except one—21 rootlets in all. The roots and rootlets were all cut. One main root was cut off and 48 cuts were made in the other roots and rootlets. Although the root system was exposed for over two days, no wilting of the leaves took place. Up to July 1918 no marked symptoms of failure had occurred.

The above experiments show what a hardy tree sandal must be and what extraordinary recuperative power the tree possesses.

As no apparent evil has resulted from the drastic treatment to which these trees were subjected, it hardly seems likely that unbalanced circulation would be produced by death or damage to the hosts as suggested by Mr. Hole.

The more we experiment in this direction, the more we seem to find how little the tree depends on its haustorial attachments.

4. THE SPREAD OF SPIKE AS SHOWN BY OBSERVATION AREAS.

Work during the year has been, in a great measure, concentrated on these observation areas, of which there are four in North Salem :—

(*a*) *Tholuvabetta.*

When this place was taken up as an observation area, spike had already spread. An area was selected more or less compact and observation was confined to 71 trees, of which four were spiked

The months in which spike appeared are shown by the following table :—

June—July 1916	...	... 4 trees
September to October 1916		... 5 "
December 1916	...	... 4 "
March 1917 ...	...	... 8 "
July 1917 ...	...	... 17 "
October 1917...	...	... 3 "
January 1918	...	... 9 "
March 1918 ...	...	... 1 "
May 1918 ...	...	... 7 "
July 1918 ...	...	... 4 "
	Total	... 62 trees, leaving 9 still unspiked.

It will be seen that in 1916 the progress was comparatively slow, there was then a period of quiescence from December 1916 to March 1917 when four trees were observed to be spiked. The greatest outbreak was, however, observed in July. After October there was again a period of comparative quiescence up to January 1918 when a considerable recrudescence occurred. There was a further outbreak in May and at the beginning of July 1918.

The most remarkable tree in this observation area is tree No. 71. It is almost hidden by a large Ficus and is situated on the margin of a cultivated field. It was discovered in a comparatively advanced stage (said to be half spiked) on 8-12-1916. In itself it was an isolated tree because there was no spike within half a mile. Under the shade of the same Ficus is a tree 25 yards away, which is quite healthy; and near the demarcation line, within 100 yards, are a large number of trees, all of which remained unspiked until recently. Tree No. 71 is now in an advanced stage of spike, having nothing left but a few tufts of very small leaves. On the 4th July no less than eight trees on and near the demarcation line close to tree No. 71 were found spiked, and the outbreak is evidently new.

It is not proved but it seems to be the case that it has taken 19 months for this tree to affect its neighbours, and for these

neighbours to show spike. This may well be compared with Dr. Coleman's tree figured in Plate XVI, Fig. 1, which grafted on 29th November 1915 showed no external evidence of spike up to October 1917.

A further examination of this observation area showed a tree on the line close to cairn 45, practically half way between tree No. 71 and the spiked area of Tholuvabetta. This tree has shown "spike" within the last few days.

(*b*) *Madeswarangudi Observation Area.*

A single tree was found spiked by Mr. Wilson in January 1915. The tree was trenched and the trench includes the nearest tree which is still quite healthy. An area of 30 acres containing 333 sandal trees has been demarcated and surveyed.

The progress of spike is shown by the following table :—

January 1915	...	...	... 1 tree
July 1916	...	...	... 4 „
May 1917	...	...	... 1 „
July 1917	...	...	... 2 „
September 1917	...	...	... 1 „
November 1917	...	...	... 4 „
July 1918 (4 days)		...	... 10 „
		Total	... 23 trees

In this area the spread of spike has been extraordinarily slow. Eighteen months elapsed before any new spike was found and it then broke out in two places, in two adjoining trees, and two trees situated close together but 80 yards away from Wilson's tree. Two centres of disease seem to have arisen : in that near Wilson's tree 14 trees have been spiked and in the other 8. The remaining tree was spiked in July 1917 and is 220 yards from the centre of infection. Up to date it has not itself become a centre from which the disease has started and, though it has been spiked for a whole year, the disease has not developed to any large extent in the tree itself.

One feature of this observation area is the large recrudescence of spike during the last few days after a period of quiescence

lasting for seven months. This recrudescence has taken place in both centres of infection.

(c) Javalagiri Bungalow Observation Area.

The conditions here differ from the preceding observation areas in the fact that the tract under observation lies between the two Javalagiri areas which have been largely attacked by spike as noted in para. 1.

A single tree was observed in October 1917 and the area. which was densely covered by lantana, was cleared when five other saplings, hidden by lantana, were found to be attacked. The area under observation is 4·60 acres and contains 340 trees. When chosen, it was half a mile west of the nearest spike in the Nandimangalam path area referred to in para. 1. The intermediate area was as carefully searched as the lantana would permit and no spike found. Spike, however, has recently gained ground in this direction, and has reached cairn 46, which is only one furlong from the observation area.

The spread of spike in the observation area was as follows:—

October 1917	...	...	6 trees
February 1918	...	...	5 "
March 1918	...	...	6 "
April 1918	...	...	14 "
May 1918	...	...	35 "
June 1918	...	...	19 "
July 1918 (12 days)	...	...	24 "
	Total	...	109 trees

It will be seen that the period of quiescence was considerable. The trees originally spiked formed two distinct centres, but the outbreak in February started two new centres; and though progress has been made in all these centres the spread, which has been extraordinarily rapid, has not been confined to these but has extended to the whole area except the Southernmost part.

A single tree at the Southernmost corner just outside the line has just shown spike. This is more than 80 yards away from the nearest spiked tree.

The spread has been in every direction, but if one direction can be singled out as showing the greatest spread, it is the northern side. This is contrary to experience in Mysore.

The very rapid spread in this area may be judged from the fact that in Madeswarammalai only 23 trees have been attacked in $3\frac{1}{2}$ years, whilst here 109 trees have shown spike in less than nine months. Even in Javalagiri Cairn 53 Observation Area only 21 trees have been attacked in the same period, though nine trees were attacked in June 1917. This area suggests that the original attack is far more virulent in some localities than in others, and it may be found that actual death ensues quicker in such localities.

(*d*) *Javalagiri Cairn 53 Observation Area.*

Observation in this area, which is somewhat threatened by an encroachment of spike from the North Javalagiri area, has not been as good as it might be. The area is full of saplings and seedlings, and spike has appeared chiefly among the saplings.

The spread of spike is as follows :—

June 1917 ...	...	... 9 trees
December 1917	...	... 1 „
March 1918 ...	...	... 1 „
June 1918 ...	...	... 4 „
July 1918 (13 days)	...	... 6 „
	Total	... 21 trees

A single tree was found early in June of last year, which is now dead. On the 13th June 1917 a group of five saplings was found in an arc of a circle. Of these four were found spiked, and the 5th, lying between 1 and 2, was suffering from lanky degeneration but not spike. It is still suffering in the same way. Of the four spiked saplings three are dead, and the 4th on its last legs with very small leaves.

The spiked trees are found at some distance from each other, and the spread from each centre does not appear to have been large.

In January 1917 one tree was found to be suffering from lanky degeneration.

On 24-1-1918 Mr. Hearsey thought that this was turning to spike, but up to date there is no spike, though lanky degeneration is still evident.

There is evidence from this area that small trees develop the disease and succumb much quicker than larger trees, and five trees have taken the disease and died in less than a year after the first appearance of spike.

5. THE PROGRESS OF SPIKE IN INDIVIDUAL TREES.

Unfortunately a great opportunity has been lost because these observations have not been properly carried out.

Considerable information has, however, been gathered on the subject. The progress of spike has been carefully recorded in several trees at Tholuvabetta up to October 1917, but subsequent to that date observation has not been sufficiently accurate.

At Jowlagiri certain trees were specially observed.

Tree No. 16 (f) was observed originally because it was found covered with Red Spider in April and June 1917.

Spike began on the 2nd and 5th small branches on 23-1-1918.

On 29-5-1918 the 1st and 3rd branches became spiked.

On 9-7-1918 the 4th, 6th, 7th and 8th were observed to be spiked.

The spiking has not been regular from branch to branch.

The same is observed with the branchlets. On branch 7 spike has begun on the 3rd branchlet from the base, and on the 8th branch on the branchlet further from the main stem and on the tip of the branch.

Tree No. 21 was observed because it was covered with Red Spider and Monophlebus on 11-9-1917. There was no sign of spike up to *20-1-1918*, since which date there has been no observation and a great opportunity has been lost.

On *9-7-1918* the three lowest branches were found to be fully spiked with the bronze form of spike, which looks as if it had been there for some time. The tips of three other branches have just started spike.

Tatahalla. Tree No. 1.—Spike began in September 1916. On *23rd October 1917* branch 1 had a tuft of spike, branch 2 was entirely spiked except the end branchlets, branch 3 was fully spiked except one branchlet at the top, branch 4 was not spiked branch 5 was spiked at the base and dead at the end, branch 6 was not spiked, and on branch 7 the lowest branchlet and the next above it were found fully spiked and the rest not spiked.

July 9th, 1918.—Branch 1 was dead and broken off. Branch 2 was completely spiked and had very small leaves at the tips of branchlet. Branch 3 was cut but has a new growth of five spiked branchlets. Branch 4 had all the branchlets spiked. Branch 5 was cut but has three new spiked branchlets, on branch 6 the tips of branchlets were dead, it had very small leaf on three branchlets, branch 7 (the whole top). The tips of branchlets were dead. The spiked leaves were small but one branchlet with yellow had normal leaves.

Tree No. 2. On *23-10-1917.*

1st branch (cut) showed no spike.

2nd branch had the lower part healthy and the rest of the tips of branchlets spiked.

3rd branch had the bottom spiked and the top was just showing spike.

4th branch (cut) had thrown out spiked growth.

5th branch and remaining branches were all healthy.

9-7-1918.

1st branch—The dead end was visible and had no spike.

2nd branch had two branchlets—

(*a*) the lowest branchlet was spiked, the 2nd branchlet was healthy, with new

flowers, but with spike at the tips, the 3rd and 4th branchlets were spiked.

(*b*) 1st branchlet was spiked, the 2nd fairly healthy but with spike at the tips.

3rd branch was spiked throughout.

4th branch do. do.

5th branch was healthy, with new flowers.

Tree No. 3. *23-10-1917.* 1st branch was healthy.

2nd branch (a branchlet) was healthy.

3rd branch was dead.

4th branch had spike just showing but was healthy on top.

9-7-1918. Branch 1 was still healthy, with new flowers.

2 was dead at the tips but had one branchlet spiked.

} A spiked shoot just coming between the branches.

3 was dead and fallen.

4 the lower fork was healthy, with new flowers; the other fork was spiked at tips of all branchlets. Two spiked shoots were growing from the base.

5 the 1st branchlet was spiked at tips, the 2nd completely spiked, the 3rd not

		spiked, the 4th was not spiked and the 5th, 6th and 7th spiked at the tips.
Tree No. 4.	*23-10-1917.*	Was healthy throughout.
	9-7-1918.	Branch 1 was healthy. 2 the 1st branchlet was spiked, the new shoot at base spiked, the 2nd branchlet dead, the 3rd branchlet had a tuft of spike at the broken end the 4th branchlet was spiked at tips and the 5th branchlet had spike at the base, the rest were healthy. 3, 4 and 5 were healthy with new flowers.
Tree No. 5.	*23-10-1917.*	The new branch below the tar mark was spiked. The branch at the fork was spiked. The lower branch was not spiked but the upper one just showing it.
	9-7-1918.	Branch 1 below the tar mark was spiked. Branch 2 was spiked. Branch 3 was completely spiked (branch 2 of Mr. Hearsey). Branch 4 (*a*) Lower was completely spiked except 3rd branchlet. (*b*) Upper, spike was just appearing at tips of 1st and 2nd branchlets, the rest healthy.
Tree No. 6.	*23-10-1917.*	Stem branching to the East had no spike. The other stem had spike in every branch.

9-7-1918. *Stem branching to the East.*

Branch 1 was spiked.

2 was dead.

3 was spiked.

4 (*a*) was dead, (*b*) was spiked at the tips, but had three normal branchlets, (*c*), (*d*), (*e*) were dead, (*f*) had two spiked shoots at the base and the rest were healthy.

5 was healthy.

6 was spiked.

7 was spiked.

8 was spiked on the lower branchlet with the top healthy.

9 was spiked on the lower branchlet with the top healthy, but one getting spiked.

Tree No. 23. This tree has been very carefully observed. Spike was seen first on 23-10-1917 on branch 2.

next on 14-11-1917 on branch 1.

next on 8-12-1917 on branch 8.

next on 18-1-1918 on branch 5.

next on 18-2-1918 on branch 4.

next on 27-3-1918 on branches 7 and 10.

next on 24-6-1918 on branch 3.

next on 9-7-1918 on branches 9, 11 and 13.

Branches 6 and 12 are still unspiked.

From this we can only gather that there is no regularity in the spiking. It has not confined itself either to the branch above or below but has jumped about in the most irregular fashion.

Trees 2 and 2 (a) in Javalagiri Bungalow Observation Area.

No. 2 is 7 feet high and has a girth of 2½ inches, No. 2 (*a*) is over 10 feet high and has a girth of 4½ inches. Both trees were

found slightly attacked in October 1917. No. 2 has bunches of semi-sized spiked leaves and one bunch of normal leaves. No. 2(*a*) is in its last stage and has nothing but a few tufts of minute bronzed leaves.

In this case the opposite has occurred to what usually takes place. No. 2(*a*) also shows, more especially when compared with tree No. 21, that bronze leaves do not invariably denote that the spike is of long standing as has been previously supposed. In fact, one seedling attacked since 25-6-1918 is beginning to show bronze leaf. In this connection the Note of Rao Sahib M. Rama Rao on page 51 of the Conference Proceedings may be referred to. " From their appearance, I thought that the trees had been attacked much earlier than those in the Jambuthu area, because the leaves were much narrower and smaller, closer and more *reddish* green, etc." Bronze spike with narrow leaves seems to show virulence of the attack rather than the age of the attack.

In studying the progress of spike in our special observation areas and in individual trees, one cannot help being impressed with the comparatively small number of trees which show spike for the first time in February, March and April, the time at which the new flushes of leaf are produced as compared with the number of trees which are observed in June and July. A study of individual trees frequently reveals the fact that the top of the tree or the very end of a branch or branchlet shows spike in June and July. Further observation shows that whereas the flush of leaf has escaped, the tree has begun to show the disease during the production of the flower. The chief flowering ought to take place in these months, but in its place comes the production of excessive leaf. It is undoubtedly on this account that we find spiked branches so rarely producing flowers or fruit. In this connection Mr. Hearsey's observations on abnormal flowers, printed at page 32 of the Conference Proceedings, are of considerable value. It seems evident that, in some cases, the poison has not sufficiently progressed to produce a complete leaf clustering, but has gone far enough to convert parts of the floral envelope into leaf.

6. Lanky Degeneration.

This feature was, for the first time, placed before the Conference in October 1917. Specimens of the disease were exhibited and were pronounced not to be spike by Mr. McCarthy who had observed this phenomenon in Sandal and Coffee. He also denied that it was a preliminary form of spike. On the other hand, Mr. M. G. Rama Rao, Conservator of Forests, Mysore, included it as a form of spike. Whatever it may be, it is by no means an uncommon manifestation and occurs in almost all our spike-infected areas. The observations carried out this year confirm Mr. McCarthy's view that this is not spike nor even a precursor of spike. It is undoubtedly true that trees which have this disease may subsequently be attacked by spike, but there are cases where trees attacked with lanky degeneration apparently recover or partly recover with the new flush of leaf. The most noticeable of these are two trees in the Hanumantharoyangudi observation area which have been placed under regular observation. Last October both trees were suffering badly and the observations showed that as the new flush was produced the trees gradually lost the characteristic appearance. At the present time both trees show traces of the disease, one very slightly and the other by no means prominently. Continued observation will be carried out to see the development later on in the year, but at present it can be said that this does not appear to have the same characteristics as spike or to be a precursor of the disease.

Another remarkable case is found in the Javalagiri Cairn 53 Observation Area, and is referred to above where a tree has been observed suffering badly for a year from lanky degeneration. This tree has so far escaped spike, though four trees in its immediate vicinity have been attacked, out of which three are dead.

Specimens of a similar manifestation in *Dodonæa viscosa* were shown to Dr. Coleman last October who was under the impression that this might be a fungoid disease, but it is pretty certain that it does not lead to the ordinary spike-like form, for the trees affected at that time have not developed this form ; though, in some instances, the two forms were seen on the same bush. Dr. Coleman promised

a more detailed enquiry into this disease but up to date has not furnished us with information on the point. Some root examination has taken place, and all that it reveals is that most of the attacked shrubs show stumps which have been burnt. It is quite possible that this disease may be connected with fire as, in some cases, though not in all, the trees which show this disease have been known to have been scorched.

7. Experiment with Infected Seed.

On the 30th June 1917, 156 seeds taken from spiked branches of spiked tree were sown at Aiyur. A large number failed to germinate and others died quite young. On the 14th October, 15 fairly healthy-looking plants were visible, but in November only nine were to be found. There are now only four plants to be found and these are, to all appearance, quite healthy.

Observation has not been nearly as good as it ought to have been. The cause of death of the plants raised has not been noted, nor have they been noted as dying.

No sign of spike has been observed.

The following seed from spiked trees has been sown this year:—

(1) *At Aiyur*—

50 on 27-1-1918.
100 on 15-3-1918.
345 on 30-6-1918.

Up to July there has been no germination.

(2) *At Denkanikotta*—

200 on 12-6-1918.

Up to July there was no germination.

(3) *At Javalagiri*—

200 sown on 13-6-1918.

No further action will be taken about these as they are adjoining the infected area.

8. Experiments with Insects.

These have been continued, but what with the tearing of the cages and the entry of insects other than those experimented

upon, the results have not been very satisfactory. Under Dr. Coleman's advice, three proper cages of gauze wire have now been set in position and await the introduction of insects from infected trees. The experiments are intended to see if spike is carried by insects rather than to see if it can be produced by insects.

The general result of the experiments has been to show:—

(1) That both the Monophlebus and Icerya produce in sandal strange abnormalities of leaf and partial or complete defoliation, but that the after result in no way resembles spike,

(2) That Solanum has died (*a*) Under an attack of Icerya.
(*b*) Under an attack of Red Spider

(3) That clustered leaf in *Argyreia cuneata* has appeared in two cases—

(*a*) when the plant was covered with Monophlebus in May 1916, the clustered leaf appeared in one branch in April 1917 and is apparent in one or two branches at the present time.

(*b*) a plant covered with Red Spider on 26-6-1918 showed clustered leaf in four branches on 5-3-1918 and is now very badly diseased.

These were neither of them caged experiments, and as the disease has already appeared in the neighbourhood and there was no control plant, it cannot be said that anything has been proved by them.

(4) *Dodonæa* has been affected by insects, but *Jatropha Curcas*, *Cipadessa*, *Zizyphus Œnoplia*, and *Acacia leucophlæa* do not seem to have been affected up to date, though the experiments have continued for more than a year.

9. General conclusions.

(1) The Komattiyur and Andiappanur experiments have given results which are entirely opposed to the theory of spike being caused by an unbalanced circulation of sap.

(2) It has not been proved how infection can spread to such long distances as those described in the isolated cases.

(3) As far as has been ascertained at present, diseased seed does not give rise to spiked seedlings, but the experiments have not gone far enough.

(4) Carriage of infection by birds or flying-foxes seems possible but nothing has been discovered to show that it is probable.

(5) Carriage by insects is also possible, more especially when the carriage is only over a comparatively short distance. Trees known to be covered with Red Spider last year now show spike but it has not been proved that the disease was communicated by Red Spider.

(6) Carriage through other plants such as *Zizyphus Œnoplia, Dodonæa viscosa, Argyreia cuneata, Cipadessa fruticosa*, etc., seems more probable.

(7) In observation areas, the plants which are affected tend to affect those round them, with occasional escapes to considerable distances. Such escapes have been found in all the observation areas.

(8) Spike develops much more rapidly in some places than others. In Tholuvabetta 62 trees out of 71 have been infected in two years, starting with four infected trees. In Madeswarangudi, starting with one infected tree, only 13 trees were infected in two years and nine months but ten more trees have recently become affected. In Javalagiri Bungalow, 109 trees have become infected in less than ten months, starting with six infected trees. In Javalagiri Cairn 53 starting with nine trees, only 12 more have become infected in a year.

(9) The development of the disease is more rapid in seedlings and saplings than in trees, and appears to be more rapid in some cases than others.

(10) Bronze spike does not necessarily mean that the disease is of long standing.

JAVULAGIRI BUNGALOW

SPECIAL OBSERVATION AREA

CORRECT AREA UP TO STREAM = 4·80 ACRES.

Scale 120 Inches=1 Mile, or 1 Inch=44 feet

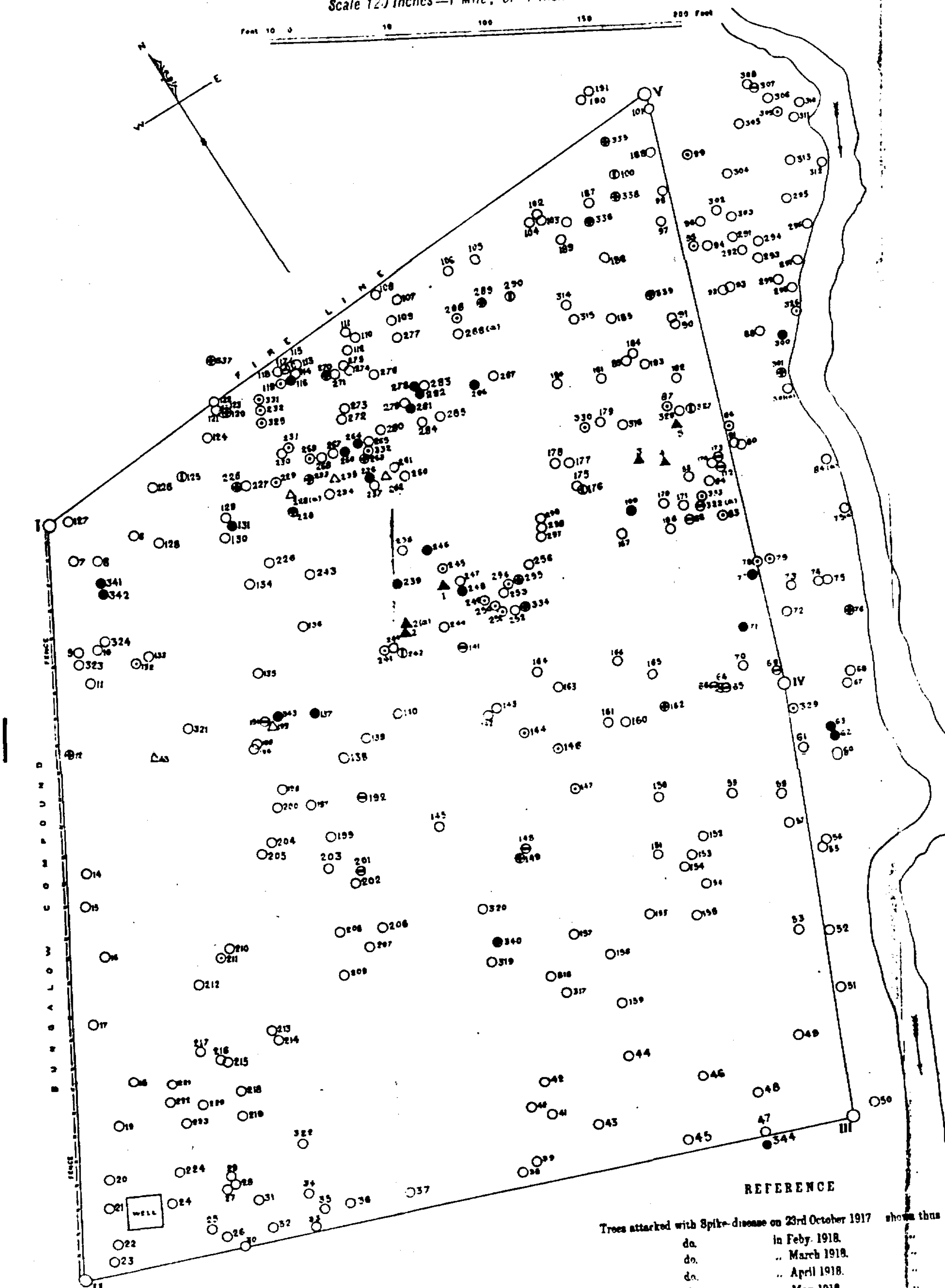


TABLE OF SPIKED TREES

Serial No. of Trees	Date of Attack
1, 2, 2(a), 3, 4, 5	23-10-17
13	14-2-18
193	22-2-18
235, 262, 228(a)	23-2-18
125	21-3-18
100, 176, 242, 290, 327	25-3-18
172, 173, 192	1-4-18
201	3-4-18
69	3-4-18
82, 148	4-4-18
66	5-4-18
141, 194, 307, 65, 322(a)	15-4-18
64, 78, 79, 83, 85, 87, 95, 99, 117, 119, 132, 144, 146, 147, 211, 229, 231, 232, 241, 245, 249, 250, 251, 254, 269, 288, 309, 325, 326, 329, 330, 331, 332, 333	22-5-18
334, 335, 336, 337, 12	3-6-18
76, 120, 149, 162, 225, 228, 233, 255, 263, 270, 289, 301, 338, 339, 340	25-6-18
62, 68, 71, 77, 116, 131, 137, 169, 236, 239, 246, 248, 264, 266, 278, 281, 282, 286, 300, 341, 342, 343, 344	11-7-18

REFERENCE

Trees attacked with Spike-disease on 23rd October 1917 shown thus ▲
do. in Feby. 1918. .. △
do. .. March 1918. .. Ⓘ
do. .. April 1918. .. ⊖
do. .. May 1918. .. ⊙
do. .. June 1918. .. ⊕
do. .. July 1918. .. ●
Healthy Sandal trees .. ○

MADESVARANGUDI

SPECIAL OBSERVATION AREA

EXTENT 30 ACRES

Scale 48 Inches=1 Mile, or 1 Inch=110 feet

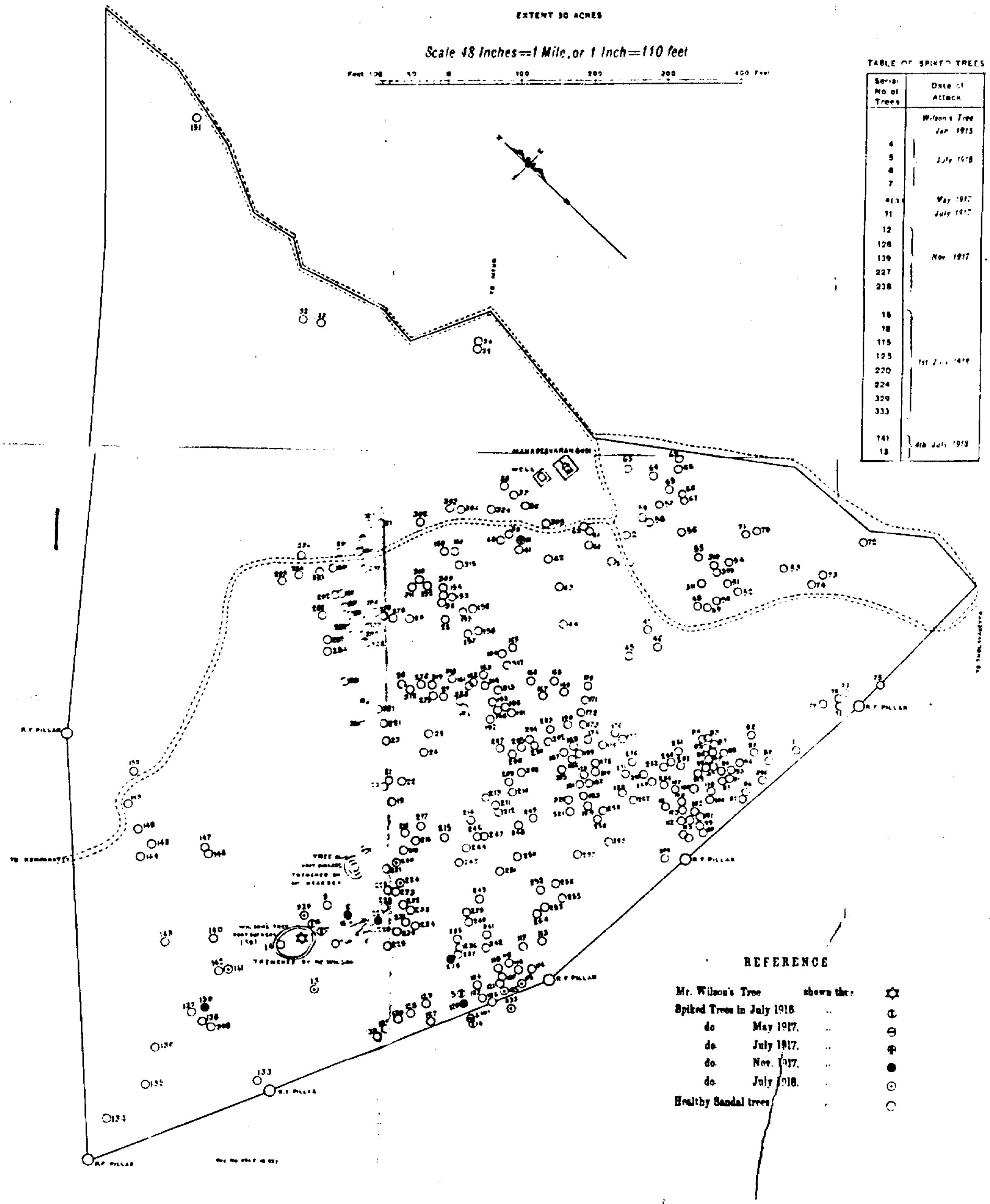


TABLE OF SPIKED TREES

Serial No of Trees	Date of Attack
	Wilson's Tree Jan. 1915
4	July 1916
5	
6	
7	
4(1)	May 1917
11	July 1917
12	Nov. 1917
126	
139	
227	
238	
15	1st July 1918
18	
115	
125	
220	
224	
329	
333	
141	4th July 1918
13	

(11) Spike has been found to manifest itself in every month of the year except August, but the period—March to July—is specially remarkable and May, June and July are far the most favourable months for spike to occur.

(12) The progress of spike in a tree does not go regularly from branch to branch.

(13) In observation areas, it is possible to tell when the disease first shows itself but not when the tree became infected. The only clue to the period of incubation is in the case of tree No. 71 in Tholuvabetta where the surrounding trees showed the disease in a period of one year and seven months. A similar time was taken in Madeswarangudi for the disease to spread from one to four additional trees.

(14) The long period of incubation, the uncertainty of whether trees are attacked or not and the escapes to considerable distance render preventive measures exceedingly difficult. In North Salem, with areas infected several miles apart, preventive measures seem to be impossible. The same is the case with the Trichinopoly District. In the Javadis, it is too early to state if the preventive measures adopted have been of any use. They involved much extra work but were well carried out, though the time taken to complete the work was rather long.

10. Preventive Measures.

Efforts during the year have been concentrated on the Nellivasal isolated area in the Javadis, and a full account of the work attempted was published in the *Indian Forester* for March 1918. The disease was discovered in 1917, and it is believed to be the only part of the Javadis which has been attacked. A fence was placed round an area of 11 acres which contained all the trees attacked. From this area 65 spiked and two dead trees were removed. In addition, 920 healthy sandal were removed, as also all the *Zizyphus Œnoplia*, *Cipadessa*, *Dodonæa* and *Scutia*. A surrounding belt, 1 furlong wide, was drawn round the affected area

and from the 40 acres thus demarcated, 2,421 healthy trees were removed. Operations began on the 13th October 1917 and closed on 4th January 1918. No spike was observed in the belt surrounding the affected area, nor has any spike been observed in the adjoining forest, though a careful inspection for three miles round was made from the 29th April to the 5th May 1918.

In the 40 acres belt, the barred species were cut, and up to the 24th June 1918 the coppice regrowth has been twice cut. It was proposed to burn the 11 acres of affected area, but this was found not to be possible as very little grass sprang up and what there was remained green.

In this case, protective measures have been given every chance. The actual area covered by disease seems to have been discovered; and, unless infection had already spread beyond the protective belt, the disease may be checked if not stamped out, but it must be remembered that if the disease came by infection over a distance of 100 miles, the same causes may operate in the future. It can only be said that, in this case, protective measures have been given every chance; and if they fail, further enquiry into the origin and spread of the disease must be made so as to improve on the measures taken.

Judging from our observation areas, we cannot be very sanguine that these measures will prove effective. In Tholuvabetta, Madeswarangudi and Javalagiri observation areas, we have found the spread to single trees at long distances and we can hardly expect anything else from this area. The absence of disease at the present time proves very little, but we must look to the flush of leaf in February 1919 and the appearance of flower in June and July; and if no spike appears at the time, the first crisis may be said to have been passed in safety.

SPIKE DISEASE OF SANDAL.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

I am afraid that some of the statements made by Mr. Lushington in the above article may convey the impression to readers of the *Indian Forester* that the undersigned has adopted an unjustifiably presumptuous attitude on this subject of the spike disease. Take for instance the following : "This article controverts Mr. Hole's *dictum that spike is caused by unbalanced circulation.*" In the paper which I read at the Conference held in Bangalore in October last, which has been printed as an appendix on p. 17 of the Proceedings of the Conference, it was clearly stated that, based on observations in the forest and in the garden, the writer "now ventures to put forward a theory as detailed below, which appears to be in thorough accordance with the facts hitherto ascertained, to ask for a patient consideration of this theory and to request the co-operation of Forest Officers in the sandal areas in obtaining the experimental proof, or otherwise, of this theory." To propound a theory which appears to offer a reasonable explantion of existing facts and observations and to ask that it should be patiently considered and tested by experiments can scarcely be said to be unreasonable or to be a "dictum that spike is caused by unbalanced circulation." Experiments to test the precise effect of various factors on the healthy development of sandal, even if they fail to clearly indicate the primary cause of the spike disease, are likely to be of considerable value in helping us to understand more clearly the treatment necessary for the healthy growth of the species and the extent to which it may be possible, at all events, to decrease the incidence and virulence of the disease. This, moreover, appeared to be the general opinion of the Conference which decided that "experiments on the lines he (Mr. Hole) suggested should be carried out as they were likely to yield valuable information," also "that all other possible predisposing factors, such as fire and damage or removal of suitable host plants, should be eliminated." (Proceedings of the Conference, pp. 7, 14.)

The South Vellore experiments alluded to by Mr. Lushington have already been discussed in the *Indian Forester* for July 1918, pp. 325—328, where it has been shown that these results do not disprove the theory of an unbalanced sap-circulation.

As regards the bearing of the isolation experiments on the general question of the parasitism of sandal and the need of host plants for healthy growth, there does not as yet appear to be any *proof* that at least some attachments have not been formed by roots which have passed below the isolation trenches.

So far as the writer's experience has gone at present, although water-culture and pot experiments at Dehra Dun have proved that sandal can *exist* without host plants, the growth appears to be very much better when haustorial attachments with suitable hosts have been formed. For this reason, it is advisable to compare the growth and increment of the isolated trees with those of similar control trees growing among suitable host plants, as has already been suggested.—(*Indian Forester*, July 1918, p. 327.)

NOTE ON SOME CHIR SEED-EATERS.

BY A. E. OSMASTON, I.F.S.

It was several years ago that I first noticed some Chir cones which at once raised my curiosity, as they had been so very neatly divested of all their scales that the result was very striking. Thereafter I made a point of trying to discover the real author of this neat piece of work, though it was not till last Christmas that I was fortunate enough to find what I had so long been seeking. The discovery was rendered all the more interesting, because the author (whom I may state at once was a flying-squirrel) had never been suggested by a single one of the many natives whom I had questioned and, in fact, I had not suspected this animal at all. As I have also collected a few notes on other birds and animals which have been observed eating Chir seed, I have incorporated the whole in a short note which, I hope, may interest some readers of the *Indian Forester*.

As the Chir Pine (*Pinus longifolia*) is a tree which produces large quantities of edible seed, one would expect to find that it forms the food of many wild animals and birds resident in the extensive forests in which this pine is found. Such expectations are fully justified by observations, and one is forced to marvel how sufficient seed survives to bring about that complete natural regeneration which is at times such a striking characteristic of the species.

My observations, I should remark, are almost entirely limited to British Garhwal and my notes must, therefore, be taken as primarily applying to this district. In order to make the account as complete as my present limited knowledge will allow, I have decided to record all the animals and birds which I have found eating chir seed.

My list then stands as follows, the local name being given in brackets :—

Man.
Monkeys (Bandar).
Flying-squirrels (Karti-kurar)
Wood-pigeons.
Nut-crackers (Kurola).
Woodpeckers (Kath khȯr).
Grosbeaks.

Each of the above will now be shortly discussed.

Man.—The Garhwali frequently eats the seed of this pine; and were it not for the trouble of obtaining it, he would doubtless become an object requiring the Forester's serious attention. As it is, the seed is mostly extracted by herdsmen in charge of cattle, whose duties take them daily into the forests and who can as well spend an hour or two in opening cones as in basking asleep in the sun. The *modus operandi* is as follows :—A heap of cones is first collected, and to do this the man generally climbs up a tree and lops off those boughs which bear the most cones, often converting the tree at the same time into a most unsightly mess. He then kindles a small fire and heats the cones till they become scorched and the scales open out. The roasted cones are then

shaken to make the seed fall out, and are usually torn open or pounded with a stone to complete the process. The seed is then eaten on the spot.

Monkeys.—I have so far only observed the common Bengal monkey (*Macacus rhesus*) doing this damage, but I think it probable that Langurs are also no less mischievous. The brown monkey tears the cones into shreds and, of course, does not use fire: and these two points serve to distinguish the cones he has pillaged from those which have been robbed by man. It will also be found that monkeys sometimes collect their cones under a tree when extracting the seed ; but though I have watched them once or twice, I have not yet discovered the reason why such heaps are made. The bark of an old Chir tree of large girth is usually very smooth and fortunately monkeys cannot climb such stems any more than they could a greasy pole. An attempt I once witnessed was extremely amusing.

Flying-squirrels.—The two photographs (Plate 31, Figs. 1 and 2) which are here reproduced show the way in which flying-squirrels completely denude cones of their scales. These are cut off at the base round the cone axis in the neatest and most workmanlike manner imaginable. The photograph also shows some cones of Blue Pine (*Pinus excelsa*) which are attacked in an exactly similar manner. The quantity of seed consumed by these animals must be enormous as it is impossible to pass through any forest of Chir (at least in Upper Garhwal) without finding the ground strewn with cones which they have stripped.

It is not certain whether one or several species of flying-squirrel contribute to this damage. A squirrel shot at about 5,000 feet elevation and shown in the photograph was skinned and sent to the Bombay Natural History Society for identification. The Society said that the animal could not at present be identified for certain as there was still some confusion amongst these animals, but that it was probably *Petaurista albiventer* or a nearly allied form. These squirrels only come out just as twilight is fading, and consequently it is difficult to become a spectator of their nocturnal carousals. Moreover, to identify an animal it has to be

CHIR SEED EATERS.

Fig. 1. The dead squirrel and some stripped chir cones.

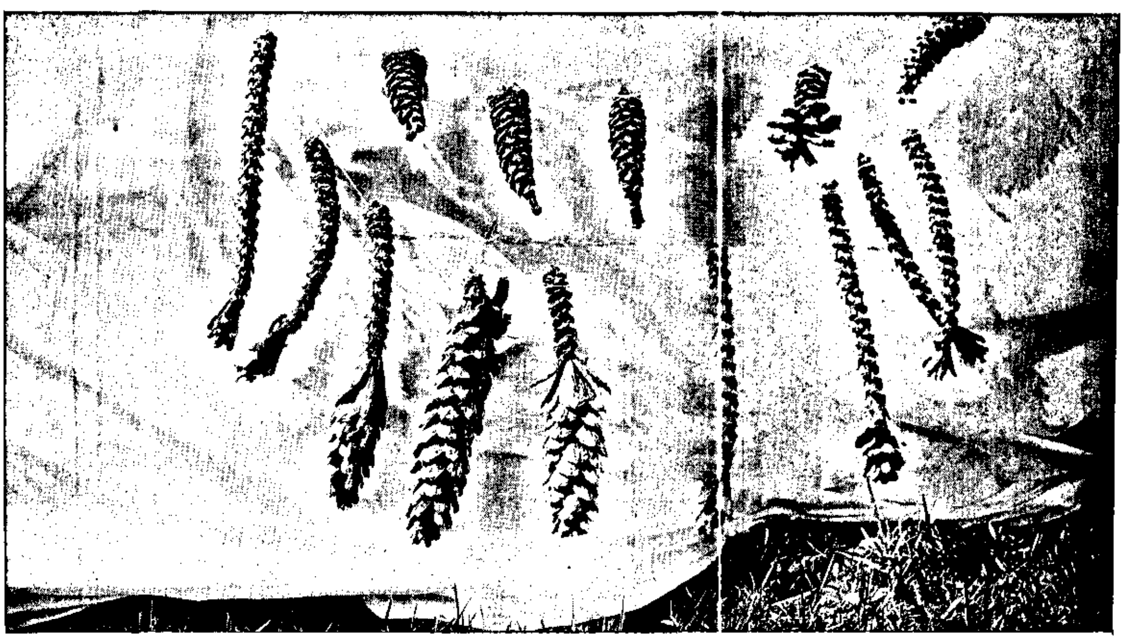


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Chir and blue pine cones stripped by squirrels.

shot, so that success depends on a rare combination of fortunate circumstances such as seldom occurs.

I must admit at once that I have never actually observed one of these squirrels eating a cone; and as some may possibly be inclined to disbelieve my conclusion, I will briefly give the facts on which it is based. Firstly, then my chaprasis, whom I had offered a reward for the discovery of the mysterious being, presented me one morning just before Christmas with a freshly attacked cone which they said had been dropped by two "chiriya" into their camp well after dark. Their description of the noiseless "chiriya" made me at once suspect flying-squirrels. A month or two later, I came across a place in the forest close to my camp where the ground was thickly strewn with freshly eaten cones. I visited the spot in the evening and to my immense delight, two flying-squirrels appeared just as it was getting dark. I watched for about half an hour whilst I heard them apparently gnawing something from time to time, but I could not follow their movements closely enough to see exactly what they were doing. Eventually I shot one of them, the one shown in the photograph (Fig. 1, Plate 31). Whilst, therefore, the case cannot be said to be absolutely proved, yet, I think, it is sufficiently so to convince any one who is unbiassed in his opinion.

If search for cones, which have been eaten by these squirrels, be made any time after March, very few freshly eaten cones will be found. This is probably due to a partial migration of the animals to a higher level amongst the Banj (*Quercus incana*) and Tilonj (*Quercus dilatata*) forests, though such a movement is admittedly mere conjecture and is lacking in proof.

Wood-pigeons.—The Eastern Wood-pigeon (*Palumbus casiotis*), which is so nearly allied to the English wood-pigeon, is not a very regular visitor to these parts of the Himalaya, and its somewhat arbitrary occurrences appear to synchronize with years when Banj acorns are unusually plentiful, the reason of course being that it feeds principally at this time of the year on acorns. It is, moreover, almost entirely a winter visitor to these parts, if not quite so, and migrates westward probably about April. An examination of

the crops of several of these birds showed that they consumed considerable quantities of Chir seed, which must be entirely picked up off the ground, as they are largely ground-feeders and could not attack a hard cone with their soft bills.

Nut-crackers.—The common nut-cracker of these parts is *Nucifraga hemispila*, and though they are commoner at most times of the year in forests above the Chir level, still in the interior ranges they are frequently found in Chir forest down to 6,000 feet elevation. Their food is probably at all times mainly composed of the seed of conifers, and the extent of their appetite may be judged from the fact that, on one occasion, I extracted 265 whole Spruce and Blue Pine seeds from the crop of a single bird. In May last, I found them not uncommon in a Chir forest where seed production had been particularly good, and I watched birds feeding here on more than one occasion. Finally, one was shot and 71 seeds extracted from its crop. These birds have very strong feet, and bill which enables them to carry out all sorts of odd gymnastic feats in order to secure the seed from the opening cones. As may be imagined, a cone hanging from the end of a bough with all its scales pointing downwards does not offer its wares in the simplest form for sampling.

These birds are probably unable to rip open a cone whose scales are closed; but, later, as the cones open, they are able to force their bill between the gaping scales and thus remove the seed with apparent ease. The seed is eaten whole without removing the shell.

Woodpeckers.—Few people would be likely to suspect a woodpecker of varying his diet with Chir seed, as, according to ornithological works, this class of bird is usually described as exclusively insectivorous. However, two at least of the species resident in Garhwal must be added to the list of birds which eat Chir seed. They are the Western Himalayan Pied Woodpecker (*Dendrocopus himalayensis*) and the Brown-fronted Pied Woodpecker (*Dendrocopus auriceps*).

Dendrocopus himalayensis lives for the greater part of the year in oak and coniferous forests above the Chir zone, but during the

coldest winter months it descends to some extent into the Chir forest, and this is the time when it attacks the Chir cones. During December 1917 I twice observed this bird sitting on the top of a Chir cone busily hammering away to reach the seed. One of these birds was shot; and, on dissection, its gizzard was found to be crammed full of bits of Chir seed with no insect remains at all.

The other species *Dendrocopus auriceps* lives very largely as a permanent resident in Chir forest. During the winter months they may or may not break into the cones as *Dendrocopus himalayensis* does, but later when the cones are opening to let the seed fall, the seed undoubtedly forms an important item in their menu. In May last I watched this species on two occasions visiting cone after cone in search of the seed, and, on another occasion, the gizzard of a bird I had shot was found to contain about half insect remains and half chips of Chir seed.

The way in which these birds eat the seed is interesting. They deftly, and with no apparent difficulty, extract a seed from an opening cone, and fly off with the seed to a convenient stem or branch into some crevice in the bark of which they fix the seed, and by a few dexterous taps of the bill break open the shell and remove the contents.

Grosbeaks.—The species commonly found in Chir forest is the black and yellow grosbeak (*Pycnorhamphus icteroides*). In a few of the most northern Chir forests, this bird is probably more or less resident, though it is perhaps more usual for them to be seen in the higher forests of Spruce, Blue Pine and Silver Fir. I observed them in May feeding on the seed from the opening Chir cones. These birds are not likely to be found much below 6,000 feet elevation, and I am doubtful if they ever visit the forests of the outer ranges even in winter.

MEASUREMENT OF A TEAK TREE.

BY MUHAMMAD HABIBULLAH SAHIB, PROVINCIAL FOREST SERVICE.

The following measurements of a teak tree felled in the Tekkadi Leased Forests, South Coimbatore Division, may be of interest :—

Girth at breast-height before felling 18′ 7′ ; approximate length of workable stem recorded before felling 30′. Unfortunately the height was not measured. Outturn, eleven logs measuring as follows :—

	Length.	Mean girth.	Volume in cubic feet.
1	12′	16′ 8″	208
2	14′	13′ 7″	161
3	10′ 9″	11′ 7″	90 } 115
	4′	10′ 0″	25
4	14′ 9″	9′ 0″	75
5	16′	7′ 0″	49
6	7′ 9″	4′ 7″	10
7	8′ 6″	6′ 4″	21
8	10′ 9″	6′ 1″	25
9	8′ 9″	3′ 10″	8
10	11′ 3″	4′ 8″	15
11	10′ 6″	6′ 0″	24
		Total ...	711

THE GIRTH-INCREMENT OF SAL IN REGULAR CROPS IN THE UNITED PROVINCES.

BY EDWARD MARSDEN, SYLVICULTURIST, FOREST RESEARCH INSTITUTE, DEHRA DUN.

Two years ago Volume VI, Part II of the Indian Forest Records, was issued from the Sylviculturist's office, attempting to indicate the girth-increment of *Sal* in irregular and untended forest. Since that time all the *Sal* sample plots laid out in the United Provinces have been remeasured, and it is now possible to obtain an idea of the rate at which the girth increases in even-aged crops.

Sixty-one sample plots were laid out in the United Provinces in crops as uniform in size as could be found; some were thinned and others were left unthinned. After 5 or 6 years the trees in each plot have been remeasured, and eliminating suppressed stems, very large trees and others showing abnormal growth, a selection of representative trees in each plot has been made, their basal area calculated at the first measurement and at the remeasurement, and from this the girth of the mean tree obtained. The increase in girth during the period has been divided by the number of years so as to ascertain the periodic mean annual girth-increment. For each sample plot a single representative annual girth-increment per stem has thus been obtained. This figure is plotted as a rectangular co-ordinate with the mean girth of the representative stems in the plot as abscissa. From these data curves have been drawn to show the variation of annual girth-increment in regular crops.

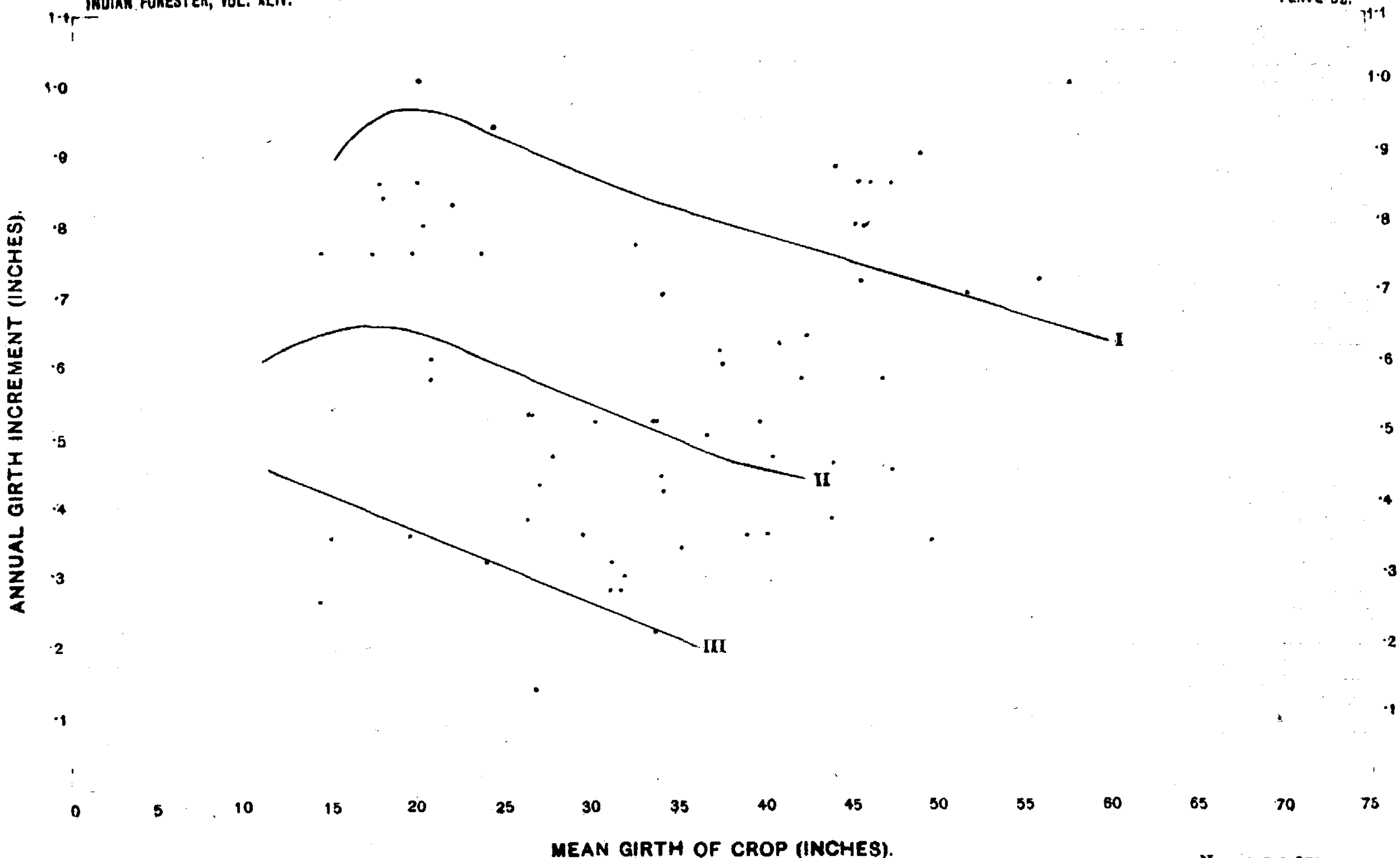
In order to check the method, the same system of graphic representation was applied to all the sample plots of Chir Pine, and the results were compared then with the girth-increment obtained by plotting the actual increase in girth as a line upon the ages as abscissæ, this being taken as the nearer approximation to correctness. The check showed that the method of plotting periodic mean annual girth-increment upon the mean girth of the stems in a plot was fairly reliable provided that the data were numerous.

An example from a single plot will illustrate the method. In Ramnagar Sample Plot No. 8, which contains 66 trees, the average girth of the main crop is now about 45 inches; so in considering girth-increment, stems of 37 inches girth or less were not brought into the calculation.

This left 33 stems as follows :—

	Girth measurement in 1913.	Girth measurement in 1918.	Increase.
1	46·2	47·9	1·7
2	37·6	38·9	1·3
3	43·7	44·6	·9
4	39·8	42·2	2·2
5	35·9	37·1	1·2
6	38·9	42·5	3·6
7	43·5	45·2	1·7
8	50·8	53·4	2·6
9	53·9	57·7	3·8
10	37·4	39·4	2·0
11	38·3	39·0	·7
12	40·5	41·5	1·0
13	39·1	40·6	1·5
14	55·5	59·4	3·9
15	39·0	40·5	1·5
16	37·0	38·0	1·0
17	41·8	45·0	3·2
18	39·3	41·1	1·8

GIRTH INCREMENT OF SAL IN REGULAR CROPS IN UNITED PROVINCES.



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	Girth measurement in 1913.	Girth measurement in 1918.	Increase.
19	43·4	45·5	2·1
20	47·9	50·4	2·5
21	43·1	45·9	2·8
22	40·8	43·6	2·8
23	38·2	39·7	1·5
24	37·9	38·9	1·0
25	53·5	56·3	2·8
26	45·3	49·5	4·2
27	34·7	37·2	2·5
28	43·8	46·8	3·0
29	40·6	43·4	2·8
30	54·6	56·5	1·9
31	46·2	48·7	2·5
32	41·0	42·5	1·5
33	40·2	42·0	1·8

Of these, Nos. 2, 3, 5, 8, 9, 11, 12, 14, 16, 24 were rejected, leaving 23 representative trees. These 23 trees, classified into inch-classes, showed a total basal area for 1913 of 18·280 sq. ft., and for 1918 of 20·328 sq. ft., equivalent to a mean girth in 1913 of 42·8 inches and in 1918 of 45·1 inches. The mean girth of the plot for the five-year period is 44·0 inches, and the periodic mean annual girth increment $\frac{45{\cdot}1-42{\cdot}8}{5}=\cdot 46$ inch.

With 44 inches as abscissa, ·46 inch was marked off on the rectangular co-ordinate.

The list below shows the *data* for each division —

Siwaliks.		Ramnagar.		Haldwani.		Kheri.		Bahraich.		Gonda.		Gorakhpur.		Pilibhit.	
14·3	·29	17·4	·76	15·0	·38	18·0	·84	20·3	·80	26·3	·38	20·8	·58	24·0	·32
14·4	·76	17·8	·86	19·5	·36	19·7	·76	24·4	·94	26·8	·14	22·0	·83		
26·4	·53	20·0	·86	31·1	·28	19·9	1·08	36·7	·50	34·2	·42	31·2	·32		
27·0	·43	20·8	·61	31·9	·30	23·7	·76	46·9	·58	37·7	·60	31·7	·28		
45·4	·80	27·8	·47	34·1	·44	29·5	·36	49·7	·35	43·9	·38	32·6	·77		
45·7	·72	37·5	·62	39·0	·36	30·3	·52	51·8	·70	44·3	·88	33·7	·22		
57·9	1·00	40·5	·47	46·3	·86	33·7	·52					33·8	·52		
		40·9	·63			35·25	·34					42·5	·64		
		42·2	·58			39·8	·52					47·5	·86		
		44·0	·46			40·2	·36					47·5	·45		
		45·6	·86									56·0	·72		
		49·2	·90												
		34·2	·70												

A study of species, whose development was known, showed that curves of periodic mean annual girth-increment follow a definite course: there is a culmination and a decline, and the culmination occurs later on good localities and earlier on poor localities; earlier with light-demanders and later with shade-bearers; the curve is generally steeper for good localities and flatter for poor localities.

With this knowledge, and with the help of distinctions for the data from different forest divisions, an attempt has been made to draw curves for two qualities. For the poorest quality the data are insufficient.

Assuming the two curves to be fairly reliable, it is possible to estimate the course of development in girth referred to age. For every second inch beginning at the 4th inch, the annual rate of increase in girth has been taken from the curve, and the length of time calculated which is required for the crop to pass through each successive stage of 2 inches. Observations suggest that 14 years is a fair estimate for a crop on I quality locality to attain a girth of 3 inches. Then on the I quality curve :—

			inch					years	14
at	4"	girth, M. A. I. is	·41	therefore from	3"	girth to	5" girth takes	4·9	18·9
	6"	,, ,,	·56	,, ,,	5"	,,	7"	3·5	22·4
	8"	,, ,,	·66	,, ,,	7"	,,	9"	3·0	25·4
	10"	,, ,,	·73	,, ,,	9"	,,	11"	2·7	28·1
	12"	,, ,,	·80	,, ,,	11"	,,	13"	2·5	30·6
	14"	,, ,,	·86	,, ,,	13"	,,	15"	2·3	32·9
	16"	,, ,,	·92	,, ,,	15"	,,	17"	2·2	35·1
	18"	,, ,,	·95	,, ,,	17"	,,	19"	2·1	37·2
	20"	,, ,,	·97	,, ,,	19"	,,	21"	2·1	39·3
	22"	,, ,,	·95	,, ,,	21"	,,	23"	2·1	41·4
	24"	,, ,,	·93	,, ,,	23"	,,	25"	2·2	43·6
	26"	,, ,,	·91	,, ,,	25"	,,	27"	2·2	45·8
	28"	,, ,,	·89	,, ,,	27"	,,	29"	2·2	48·0

at	30″	girth, M. A. I. is	inch ·87	therefore from	29″	girth to	31″ girth takes	years 2·3	50·3
	32″	,, ,,	·85	,, ,,	31″	,,	33″	2·4	52·7
	34″	,, ,,	·83	,, ,,	33″	,,	35″	2·4	55·1
	36″	,, ,,	·815	,, ,,	35″	,,	37″	2·5	57·6
	38″	,, ,,	·80	,, ,,	37″	,,	39″	2·5	60·1
	40″	,, ,,	·785	,, ,,	39″	,,	41″	2·6	62·7
	42″	,, ,,	·77	,, ,,	41″	,,	43″	2·6	65·3
	44″	,, ,,	·755	,, ,,	43″	,,	45″	2·6	67·9
	46″	,, ,,	·74	,, ,,	45″	,,	47″	2·7	70·6
	48″	,, ,,	·725	,, ,,	47″	,,	49″	2·8	73·4
	50″	,, ,,	·71	,, ,,	49″	,,	51″	2·8	76·2
	52″	,, ,,	·695	,, ,,	51″	,,	53″	2·9	79·1
	54″	,, ,,	·68	,, ,,	53″	,,	55″	2·9	83·0
	56″	,, ,,	·665	,, ,,	55″	,,	57″	3·0	86·0
	58″	,, ,,	·65	,, ,,	57″	,,	59″	3·1	89·1
	60″	,, ,,	·63	,, ,,	59″	,,	61″	3·2	92·3

Comparing the rate of girth-increment now indicated for *Sal* in regular crops with that for irregular crops published in Vol. VI, Part II of the Indian Forest Records, the statement made in the introduction to that publication: "The object of publishing these statistics is to show the rate of growth and the outturn under present conditions. This is useful as indicating in some cases the need for alteration of treatment" may be considered justified. The evidence as to the effect upon increment of regularity as opposed to irregularity in crops of *Sal* is surely convincing.

GIRTH INCREMENT OF SAL IN REGULAR CROPS IN UNITED PROVINCES.

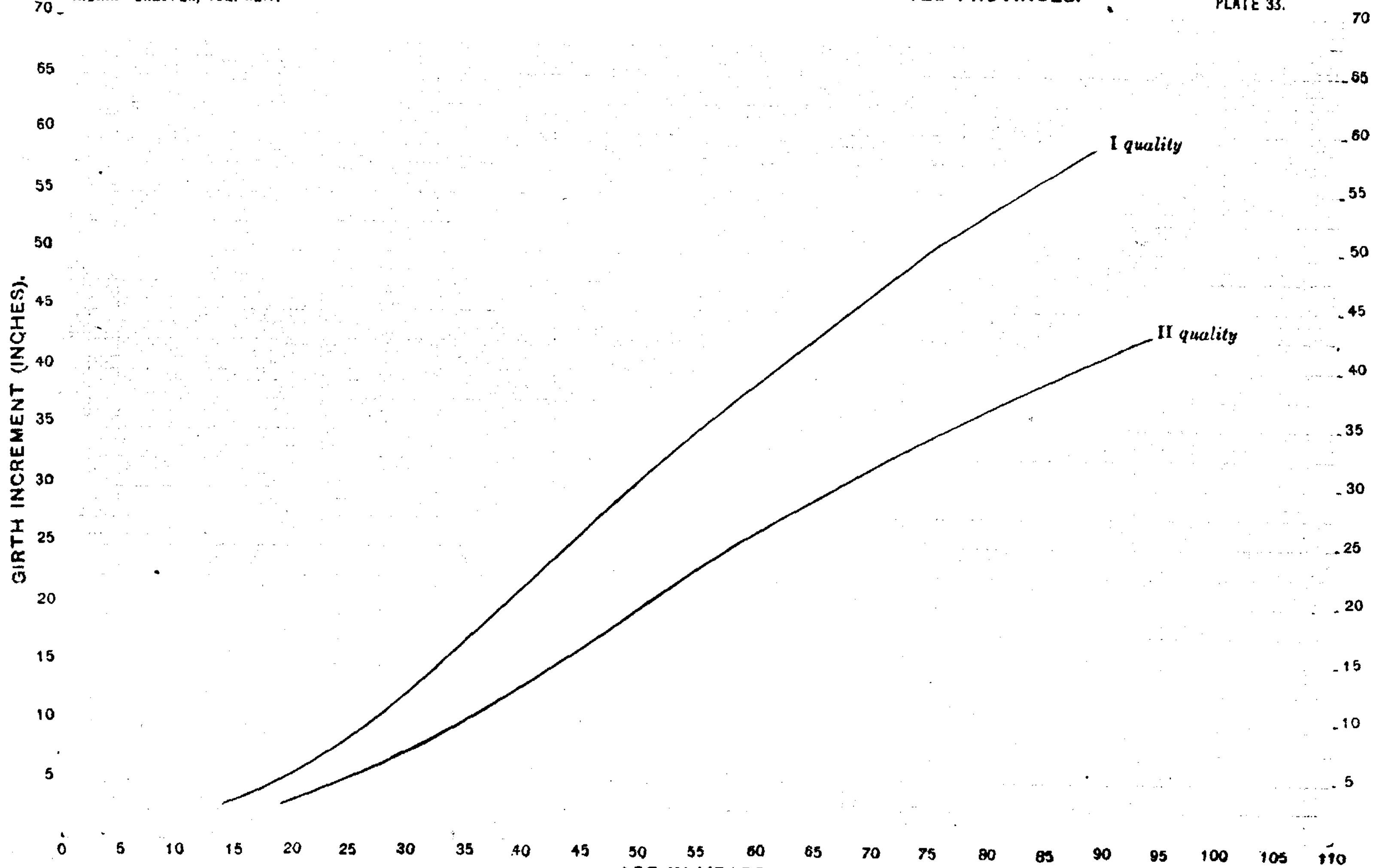

Photo Zinco September, 1918 —No. 3117-1 85

Age (years).	Girth (inches).	
	I quality.	II quality.
15	3	
20	5½	3
25	9	5
30	12½	7½
35	17	10
40	21½	13
45	26	16½
50	30½	20
55	35	23
60	39	26
65	43	29
70	46½	32
75	50	34½
80	53½	37
85	56½	39
90	59½	41
95		43

MESOPOTAMIA AND AFFORESTATION.

BY J. W. NICHOLSON, I.F.S.

The present occupation of Mesopotamia and the expectation that it is destined to remain under British Administration after the War opens up a question interesting to foresters, namely, the extent to which any large scheme of afforestation is either advisable or practicable.

Lower Mesopotamia, which may be here roughly defined as the territory lying within the limits of the alluvial region, bounded on the east by the foot-hills of the Pusht-i-kuh, on the north by the Jebel Hamrin and gravelly plains, and on the west by the Syrian and Arabian deserts, is by this time, owing to its popularity as a scene of operations, generally familiar as regards both climate and characteristics, and a description is hardly necessary. Sufficient to state that this vast plain is characterized by clay or sandy clay soils of great depth and remarkable potential fertility. Formerly the granary of the ancient world, now by reason of Mongol invasion and Arab apathy chiefly desert waste, it can be restored again to its former prosperity and made to contribute largely to the requirements in grain of the world of to-day. With this object, comprehensive plans for an extensive irrigation system were prepared and a commencement made in their execution. However, owing to the procrastination of the Ottoman and the outbreak of War, out of the various works contemplated the Hindie barrage on the Euphrates is the only one so far completed. It is clear that there is here no great scope for afforestation, since a soil of such promise as regards cereals production must necessarily be largely given over to the demands of agriculture. One might visualize also the pernicious influence which the establishment of a vast forest might have on the present dry and comparatively healthy climate, engendering for the generations to come a damp and malarious atmosphere which would gradually undermine the splendid physique and virility of the Arab race and prove little attraction to the most enthusiastic of foresters. Such a prospect, although perhaps wholly imaginary, is scarcely attractive.

Although any vast scheme of afforestation is thus out of the question as far as these alluvial plains are concerned, it is not implied that no afforestation at all should be attempted. It would be hard to find in the whole world any region of similar extent and fertility which is so remarkably devoid of tree growth, that is if we except the ubiquitous *Phœnix dactylifera* and such fruit trees, *e.g.*, mulberries, figs, oranges, plums, etc., as are frequently grown in association with it. Timber trees are a very rare phenomenon, one might almost say freaks of Nature were it not for the knowledge that it is not through any disinclination or disability on the part of Nature to produce them but thoughtless extermination at the hands of generations of men recklessly satisfying their own requirements without regard for the future. Personal acquaintance is limited to one small grove situated on the bank of Tigris, and which has apparently escaped the ruthless axe of the Arabian through the sanctifying influence of the presence of a sacred tomb, containing no doubt the earthly remains of some holy follower of the Prophet dear to Shiah memory. Enough to realize the terrible dearth of timber and firewood of any description. As an instance, it reflects itself in the limited style of local architecture which an absence of timber of necessity imposes. Neither Persia, as a source of timber supply, nor Kifri, as the home of a black product which masquerades under the name of coal, materially relieves the situation, the cost of transport being too prohibitive. The date-palm at present satisfies the humble needs of the uncivilized local inhabitant, trunk, frond and root being put to their various uses. But any one condemned to practise the art of kindling a fire from a log of palm wood soon comes to the conclusion that this is a matter for one gifted with the calm philosophic temperament of the East or the indifference of a savage.

It is evident then that if it is proposed to carry out an extensive irrigation system, and to elevate the people to that same level of prosperity which, if we may believe historical records and traditions, this country once enjoyed, some endeavour must be made to meet, as far as possible locally, the inevitable increase in the requirements of the population in respect of small timber

and firewood. The solution of the problem would appear to be in the establishment of small scattered plantations, more particularly on all waste areas, such as the numerous mounds and ridges which mark the sites of former towns and villages, canal banks, etc. Such a plan carried out simultaneously with irrigation channel construction and extension of cultivation, would involve but a slight transgression on the demands of agriculture and would serve to create local and easily accessible sources of wood. Supervision might be exercised on village forest lines, but the whole scheme would be subject to the necessity for co-operation on the part of the cultivators concerned. Once assured of the advantages to be reaped, this might not prove too difficult to obtain. The benefit to the country would be immense, not only directly through the satisfaction of wood requirements but indirectly through the resulting beneficial change in its monotonous appearance, and even if the Arab's sense of æstheticism be a little blunt he is sufficient of a hedonist to appreciate the delight of being able to escape the fiery rays of the noonday sun by repairing to the inviting shade of the local arboretum.

Considering now the case of the country surrounding these alluvial plains, neither the Syrian desert nor the sandy gravelly tract into which the alluvial region gradually merges on the north-west at present recommend themselves as possible areas for afforestation, that is, unless these regions too are eventually embraced in some irrigation project. We are left with the foot-hills of the Pusht-i-kuh, the Jebel Hamrin and the country which lies to its north-east. It is here, one may speculate, that forestry will possibly be allotted its place in the Mesopotamian sun.

Although personally unacquainted with the foot-hills of the Pusht-i-kuh south of Mendalie, the conditions there probably approximate sufficiently to those described below to justify the conclusion that if afforestation is practicable in the one instance, it will also be so in the other.

The country north-east of the Jebel Hamrin consists of a series of ranges of low hills running approximately north-west, and interspaced with flat stretches of very fertile plain. As one

proceeds northwards up the Diyalah, which in its course intersects these hills, or eastwards towards the Persian frontier, the plains tend to diminish in extent and become more broken in character until eventually one meets with a confused mass of country where plain and hill are no longer sharply defined one from the other Geologically, this area is a very recent formation, no part dating back beyond the miocene. The underlying rock is a soft friable sandstone, shale, or gravel—the latter almost entirely of limestone origin. Extensive deposits of gypsum are also locally met with. The soil thus varies from a pure gavel to a sandy clay or rich loam, according to the proportion present of the above rocks. Consequent on the absence of any hard rock, erosion is very rapid and the configuration of the ground still very indeterminate, only the higher ridges which, as one would expect, are composed of gravel, having attained any definition of form. The soils derived from the decomposition of shale and sandstone are generally of good depth, while the gravelly soils are frequently of such promise as to warrant a grudging expenditure of energy on the part of the Kurd cultivator.

The Jebel Hamrin, which geologically may be regarded as the most recent of any of these hill ranges, may be best described by imagining a long narrow plateau about six miles wide and 200 to 300 ft. above the level of the plains. Owing to the processes of erosion, this plateau has become broken up into a bewildering complex of small hills and nullahs. Along the north-east edge of the plateau and about 200 ft. above its level rises a well-defined ridge of gravel rock which, on the further side, slopes down directly to the plains on the north-east. The highest point on this ridge is about 650 ft. in height. The soil in the Jebel Hamrin is not generally characterized by the same depth as is encountered in most of the other ranges, and springs are rare and usually brackish. These two factors probably account for the almost entire absence of any traces of cultivation.

It is not worth while going into a detailed description of any of the other ranges. Some of them being entirely of gravel rock do not exhibit the same broken configuration of ground as is met

with in the shales and sandstones of the Jebel Hamrin, but they all resemble the latter range in that the highest and most defined ridges are always of gravel, and differ in that springs are more abundant. The Aq Dagh, a gravel range rising to a height of about 2,300 ft. and along the top of which the very conjectural Turco-Persian boundary at present runs, is an exception to the general orientation of the other ranges in that it runs from north to south. At its northern end one strikes a low apology of a limestone ridge, the old shore of an inland sea and the site of what must be one of the largest deposits of gypsum in the world. This ridge is a continuation of a higher and better defined range across the frontier.

The broken plains resemble the Jebel Hamrin in character of rock and soil, and in general aspect save that they are surrounded by hills and not flat plains. The soil is naturally deeper and shows signs of considerable cultivation. Locally they yield petroleum oil of excellent quality.

The climate of this region is more or less identical with that of the Mesopotamian plains, rainfall being ordinarily confined to the months October to March. The temperature in summer probably equals, and in the particular case of the Jebel Hamrin certainly exceeds, that normally met with in the plains, while the cold in winter, more especially in the higher altitudes, is more intense.

It has been seen above why, in the case of the alluvial plains of Mesopotamia proper, afforestation was impracticable on a large scale but the establishment of small scattered plantations is advisable. When we consider the case of the country north-east of the Jebel Hamrin, we find the conditions there differ in several important features. Firstly, we are not dealing with land which is essentially agricultural; on the contrary, the majority of the land, if we except the stretches of unbroken fertile plain, comprises absolute forest or pasture soil. Secondly, the cultivation carried out in the hills and broken plains is independent of irrigation. The possibility of this independence appears to be due to the following factors, *i.e.*, a somewhat greater rainfall, better soil-aeration, and consequent better retention of moisture in the soil, and the presence of perennial springs and streams—these latter

affording sources of water-supply to the cultivator. "(*N.B.*—Although, during the cold weather, cultivation on the plains is carried out independently of irrigation, it is confined in extent to the vicinity of the big river banks and the results fluctuate in accordance with the annual rainfall, *i.e.*, in 1916-17, owing to the fall below the average, the crops were poor; on the other hand, as far as the evidence shows, the hill harvests are invariably to be relied upon)......" Thirdly, the absence of timber is not so noticeable as in the case of Mesopotamian plains, its employment in the construction of buildings being general.

The frequency of streams and springs admits of riverine species of shrubs and small trees finding considerable space for growth, and owing to the injurious effect of cold on the date-palm the latter is not so readily allotted every available space of ground within touch of water. Also, the stunted Oak forests growing on the mountain slopes above the passes on the Persian plateau are an accessible source of timber to villages in their proximity. All these factors have their influence on the mode of life of the native Kurd—this latter race replacing the Arab (who, by the way, confines himself to altitudes lower than 2,000 ft.) in the whole of this region with the sole exception of the Jebel Hamrin and the adjacent Kizil Robat plain.

It is not easy in these unsettled days of War to gain a true acquaintance with the habits of the Kurds, but they appear in normal times either to live in permanent villages of comparatively well-constructed houses and cultivate the surrounding ground, or to be nomad shepherds, usually the servants of the settled villager or some potent chief, ever wandering with their flocks at the season's dictation in search of the best pastures.

It is patent that there is here not the same necessity for establishing small plantations to meet local requirements in respect of firewood and small timber. Nor need we anticipate such an inevitable increase in local demands as would appear probable in the case of the plains, which only require extensive irrigation to be able to support an enormous population. But, at the same time, we have here, at our disposal, large tracts of absolute forest

land which at present serves as pasture of poor quality and quantity (judging at least from the toughness of the proposition which the local mutton presents to the delicately nurtured occidental stomach). In view then of the absolute dearth of forest in the whole of the Mesopotamia, the remoteness of foreign supplies of timber, and the prosperity which the country is distined to obtain as one of the granaries of the world, it would appear economically sound to inaugurate a suitable policy of afforestation, and to divert some portion of this land from wool production to that of trees. Although the financial results of such a venture must naturally remain rather a hypothetical question, one might reasonably expect a higher revenue than is obtainable under present conditions. Indirectly the proposed forests would fulfil a great protective rôle in their conservation of moisture and restraining effect on the severity of floods in hill-fed rivers and streams. The beneficial results of even a partial control over the water-supply to the plains would alone be a sufficiently cogent reason to attempt afforestation.

Assuming then that the advisability of establishing a forest area is based on sound economic principles, it yet remains to be seen whether such a scheme is sylviculturally and politically practicable. To begin with, although as far as can be seen, the soil conditions are extremely favourable to forest production, it is by no means so clear that the climatic conditions are equally admissible. The key to the solution of the question lies in the amount of rainfall, and in the absence of available records only a vague speculation is possible. The rainfall certainly increases as one proceeds into the hills, but to what extent? Whereas round Baghdad the average fall is about 5 or 6 inches per annum, are there any reasonable grounds for inferring that it will be double or treble in the hills or, at any rate, sufficient to support forest growth? That is the problem. If indeed climatic conditions are favourable to forest growth, one has to explain the cause of all this area being so destitute in this respect. The only possible explanation postulates utter and absolute annihilation of former forests at the hand of man. It may well be that the teeming millions which,

during the era of its prosperity, Mesopotamia used to support have, in the long course of history, exhausted the only accessible sources of timber, the work of destruction being nobly co-operated in and completed by man's faithful allies in the domesticated animal world. Natural reproduction may then have been rendered an impossibility, either through the disastrous effects of promiscuous grazing or perhaps, in many instances, through subsequent excessive desiccation of the soil. If the latter was general, then the outlook from a forester's point of view is not very hopeful. Fortunately, there are one or two indications in favour of the theory that afforestation is practicable. Firstly, over portions of the hills and broken plains cultivation of cereal crops is practised independently of irrigation and apparently with profitable success as the Kurd, whose adopted family axiom is certainly not *Labor omnia vincit* is not in the habit of doing any unnecessary or fruitless work. This is a stage better than the conditions in the plains. Secondly, on one of the hills, though across the frontier, there is an actual example of a thriving but rather stunted Oak growing on gravelly soil at an altitude of about 2,000 ft. As it is surrounded by the ruins of an old wall, it probably owes its survival to the possession of some sentimental or sacred interest. Finally, it is interesting to note that, in the traditions which centre round the romance of the wooing of the princess Shirin, the surrounding hills are all covered with stretches of boundless forest. Although, even if true, scarcely a proof of the possibility of afforestation at the present time, in view of the inevitable changes which climatic conditions must have undergone, it is at least an attractive vision—a light, which shining through the dim vista of the past, helps to dispel the mist of doubt and inspire the forest pioneer with hope and courage in his efforts to restore the phantom shades of an old world forest.

The optimistic conclusion, after a survey of all these conditions, is that afforestation is practicable but not everywhere. The Jebel Hamrin, by reason of its aridity, is too doubtful a proposition, but the moister regions further north or nearer the mountains suggest themselves as areas worthy of experiment.

Finally, one has to consider the possibility politically of reserving areas for afforestation. The Kurds, as a whole, are an independent race who obey few laws save their own, and acknowledge little suzerainty save that of their own respective chieftains. Neither the nomad shepherd nor his opulent master of more sedentary habits is likely to view with favour any limitations to the right to graze his flocks where the spirit prompts him and inter-tribal laws permit. The laudable objects of afforestation will, in his philosophy of life, find scanty appreciation, and a budding young plantation be regarded less as a forest in embryo than as so much ambrosia for his goats, thoughtfully provided through the misguided zeal of a solicitous government curiously ignorant of pastoral arts. The demarcation of a reserve and the attempts to establish a forest would be absolutely useless without the assent and co-operation of the Sheikhs concerned. Not only would one's embryonic forests suffer a premature and lamentable end but, in his turn, the ingenuous forester would eventually provide a tempting target which the local sniper, in obedience to some categorical imperative or as an expression of his extreme disapproval, could hardly be expected not to take advantage of. This essential co-operation on the part of the Sheikhs will not be so easy to obtain, as rights to land would only be relinquished with great reluctance. The only possible plan would appear to be to come to terms with the chiefs concerned, granting them certain rights over the removal of forest produce and possibly also of restricted grazing, together with a compensation in money paid annually on a computation of the land value from a grazing point of view, balanced on their part by guarantees that the tribesmen would neither interfere with the general administration of the forest nor make the executive officer a test of their powers of marksmanship. On such a basis, a settlement might be possible and local opposition overcome.

It is thus apparent that, taking into consideration the numerous difficulties that have to be overcome before a comprehensive forest policy can be initiated and the many doubts as to the possibilities of sylviculture under these climatic conditions, afforestation

must, to begin with, be very experimental in character and limited in extent. The more fertile tracts in the hills and those portions of the broken plains which are not at present given over to cultivation recommend themselves as the most likely fields for experiment. If the results obtained from these preliminary plantations are successful, then a more energetic and expansive policy could be pursued. Even if afforestation is found by experiment to be possible only in selected areas, its effect might prove such as to increase the moisture in the more arid tracts, and render them sufficiently fertile to be capable of supporting tree growth. Similarly, if, at present, the culture of xerophytic species of only secondary importance is possible, in rotations to come under ameliorated conditions, the introduction of more profitable species might be successfully affected.

If it is destined to be our privilege to administrate the fortunes of a country of such great possibilities as Mesopotamia, it is our duty to exploit the more problematic and obscure potentialities in respect of timber production, no less than its evident promise as a vast granary. The conversion of barren hills into a land of splended forest would be no less a monument to British enterprise than the construction of a net-work of canals, greater perhaps since the former would be expression of a wise speculation on the part of a far-seeing Government, the latter merely the satisfaction of an obvious want, an investment of gilt-edged security. If the vision of a forest-clad Hamrin appears too much of the nature of a dream impossible of realization, a pleasant flight of the imagination, nevertheless it possesses an alluring charm, difficult to dispel, for eyes made tired by the monotony of a lifeless solitude.

In conclusion, as the above is merely an unscientific record of impressions formed during the course of various but limited wanderings in a country either really or potentially hostile, it is open to grave criticisms by those in possession of fuller data and better acquainted with the resources and needs of the country as a whole. If, owing to limited knowledge or false interpretation of facts, these impressions should unhappily not approach verisimilitude, apologies for misrepresentations are here duly offered.

EXTRACTS.

TANNING INDUSTRY IN SOUTH INDIA.

POST-WAR PROSPECTS.

The following Press *Communiqué* has been issued by the Madras Government :—

The Madras Government have recently been considering the prospects of the Tanning industry after the war. The position, so far as can be foreseen, will be that while the Madras hides will have earned a great reputation, they will be confronted by two dangers, *viz.*, competition from North India and re-introduction of adulteration. The best method of preventing adulteration is being considered both by Government and by the trade : this paper will deal with the competion from North India.

The pre-eminence of the South India Tanneries is due to the fact that the Avaram (*Cassio auriculata*) bark is perhaps the best tanning agent for the production of soft and good leather by unskilled labour and is only found in South India. It is not due to the number of the raw hides available, for most of the hides come from North India. Thus of the two raw materials required for tanning, the tanning material and the hides, South India possesses the first, but not the second, while North India possesses the second, but not the first.

Tanneries in Northern India have been working for the last year to discover a tanning mixture from indigenous materials which can turn out a leather as good as Avaram tanned leather. They have obtained exceedingly cheap tanning mixtures, but so far nothing quite so good as Avaram. They have, however, obtained surprisingly good results, and this makes it the more necessary that the normal price of Avaram should be much reduced. The normal price may be taken to be Rs. 22 per candy or about Rs. 100 per ton and the smallest excitement sends the price up to Rs. 150 or Rs. 200 a ton when it is the dearest tanning agent in the world. If, therefore, the Madras trade is to survive, the normal price of Avaram should be reduced to about Rs. 10 to Rs. 15 per candy.

This can only be done by planting Avaram like coffee and tea, instead of wandering after it over miles of country. Sown in furrows three feet apart it grows into a dense plantation which can be cut all the year round and should yield from two to four candies per acre. As it will grow on the poorest land, the *kist* to be paid would be very low and a price of even Rs. 10 per candy should give a profit. The plantation should cost very little to maintain as neither cattle nor goats will touch this shrub.

Collectors have, therefore, been instructed to take into favourable consideration applications for lands for growing Avaram, and the *darkhast* rules will not be applied in dealing with such applications. The conditions will be as follows :—No assessment will be charged for the first four years, after which full assessment will be charged. At least a quarter of the land should be planted up every year. The land will be resumable at any time without compensation if it is not kept up under plantation with Avaram. These penal conditions are necessary to guard against land grabbers, but will not be used unfairly against *boná fide* assignees who satisfy Government with regard to any breach of the above conditions.

Districts where suitable land is available are Bellary, Anantapur, Cuddapah, Kurnool and Nellore. Details of blocks of land available in Anantapur and Nellore may be obtained at the office of the Controller of Tanning Materials, Sea Customs Office, Madras, or from the Collectors of the districts. Details of lands available in the other districts named may be obtained from the Collectors. The District Forest Officers are collecting seed in many districts and will hold it for sale, and the Controller of Tanning Materials can inform any applicant where to obtain seed. —[*The Indian Trade Journal.*]

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FOREST CONSERVANCY.

BY E. A. SMYTHIES, I.F.S.

It seems to me an extraordinary fact that the main results of the work of our Department in India receives, practically speaking, no publicity or recognition. Our annual reports and quinquennial reviews show in numerous statistical tables the results of various aspects of our work, the increases of revenue and output of forest produce, the results of fire-protection, of experiments, the grazing problem, the financial results, etc. Leader writers in the daily papers, reviewers, publicists and the intelligent public generally catch on to the salient points of these reports and comment at length on the constantly improving financial results, for example, or the necessity for new methods of exploitation or of a new commercial branch of the Department. But all these matters in our present stage of development are mere incidentals. The popular and erroneous idea of the activities of the Forest Department is, I think, very typically represented by that inane question

so many of us have so often been asked : "What does a Forest Officer have to do? Do you go round *and cut down trees?*" The stock reply to this, *i.e.*, that our work is exactly the opposite and we have to go round and grow trees, never fails to produce a surprised comment, and yet it is so obviously our main work at present.

In nearly all cases in the beginning, forest areas were not made over to the Department until those areas had been ruined to a greater or less extent and the growing stock reduced to a mere fraction of what those areas were capable of producing. And ever since, silently, methodically, and almost unnoticed, nature and the Department have been at work to build up again the depleted capital.

This duty of the Department is well recognized. Refer, for instance, to the views of the Government of India in their quinquennial review of Forest Administration, 1909-10 to 1913-14.

"In forest administration the object in view is two-fold—first, to conserve and improve the forests and *this is the first concern of the trained staff*"—(our italics). The duty then is recognized, but it seems to me we make very little attempt to show how we are fulfilling our duty. There is a close analogy between forestry and agriculture, if we remember that the agricultural rotation is a year and the forest rotation is 100 years.

In agriculture, we have the seed time in spring, weeding and tending of the crop in the summer, and the harvest in autumn. Our spring started 50 years ago with the commencement of the Forest Department, we are now in the summer of weeding and tending, while the autumn of our harvest is still half a century ahead. This generalization applies only to the *best* of our forests, where organization was started 50 years ago, to the teak forests of Bombay and Burma, the Sal forests of the U. P. and Bengal, the forests of the Himalayas. Many of our forests are still only at the beginning of things. For example, 30 per cent. of the forest areas in the U. P. only came under the Department a short five years ago. But the point I wish to make is that in our highest revenue-producing forests and under the most favourable conditions,

we are still only growing our crop and everything else is incidental. For our incidental exertions we get full credit, for our main and principal work there is no recognition. Let me give an instance. The revenue of the U. P. forests has doubled in the last six years and trebled in the last 20. We underline this in our reports, and higher authorities note and make flattering comments. But who realizes or gives us credit for the fact that since we took charge we have quadrupled our growing stock and before our final harvest ripens we shall quadruple it again?

Let me quote a concrete example which I happen to know of. In the revision of the Naini Tal Working Plan recently careful re-enumerations over a certain area—an area close to Naini Tal itself and subject to heaviest demand—showed that in 35 years, in the face of this heavy demand, we had exactly quadrupled the growing stock (*i.e.*, from 11,000 to 44,000 trees). This is a small but established example of what we know to be happening everywhere.

This has been, is, and for another 50 years will be, the real criterion of our work and the main object of our existence.

This essential fact is more or less recognized by the Department; there is no doubt it is not, and never will be, recognized generally unless we invite attention to it in some way, and make it more obvious in our annual reports and reviews. It is, I admit, not an easy matter to bring this aspect of our work into adequate prominence. It is only on occasions (*e.g.*, the revision of a working-plan and re-enumerations of definite areas at long intervals) that we obtain any statistical data to support our case. But I would suggest that when such examples do crop up, we should give them full publicity. They form a tangible point that can be taken up and noted on in reviews, etc., and then be brought before the public eye. Again, an occasional vivid paragraph in our annual reports would assist to give publicity to this aspect of our work. A reference to Chapter IV of the Forest Code, however, (which prescribes the form and headings of our annual report), will show that there is no suitable heading at all for such a paragraph or subject. It does not fit very well into sub-sections (3) and (4) of

Chapter II (*i.e.*, "Protection of Forests" and "Sylviculture"). The new Chapter IV introduced last year "Research and Experiments" might easily have been made to include researches to show the improvement in our forests, but for the very limited application the present wording or definition of this chapter allows (see addenda slip No. 17). I have never understood why this chapter should have been limited to the record of research and experiment on "the introduction of *new* species and the *utilization* of indigenous growth. Most of our research and experiments, after all, concern themselves with the sylviculture of indigenous species (Chapter II, section 4 (*d*), which allowed for this, has now been deleted, and yet the new Chapter IV does not include it. The latter might with advantage be amended by the addition of the words "and Sylviculture" after "Utilization").

However this is rather a digression. To conclude, the main point I have tried to bring out is that the great work which we are doing is the enormous and continual increase in our growing stock—our Forest Capital—for the benefit of posterity, and that this aspect of our work receives a very inadequate recognition.

NOTES FROM DEHRA DUN HERBARIUM.

No. III.

Continued from "Indian Forester," XLIV, p. 349.

SOME INDIAN SPECIES OF ZIZYPHUS.

BY R. S. HOLE, FOREST BOTANIST.

In 1862 Edgeworth described a Punjab plant which he assigned to ***Zizyphus Jujuba***, Lamk., and called variety ***hysudrica*** (***Journ. Linn. Soc.***, VI, 201-202).

The following notes regarding this plant are taken from Edgeworth's description :—

" I am not sure that it is anywhere truly wild, though I have observed it in the desert, but probably dropped by man or bird. This species is immediately noticed on entering the western part

of the Cis-Sutlej States, where it first appears as a small tree (the branches not drooping as the typical wild or cultivated *Jujuba*) and with almost smooth leaves. There is a slight pubescence in young specimens, but they are almost glabrous when old. The fruit is globular and dark coloured (greenish purple), not orange or red like the wild Ber, or green (or yellow) like the cultivated. The leaves are usually roundish ovate."

In India, *Zizyphus Jujuba*, Lamk., is remarkably constant as regards the presence of a dense pale or ferruginous tomentum on the under-surface of the leaves and the length of the petiole, but in both these important characteristics Edgeworth's plant differs strongly from *Jujuba*, apart from the shape of the leaves, habit and colour of the fruit. Judging from the observations and herbarium material at present available, the writer is inclined to consider that this plant is a good species quite distinct from *Zizyphus Jujuba*, Lamk., and probably more closely related to *Z. Spina-Christi*, Willd.

The chief characteristics which at present appear to distinguish *Z. hysudrica* from its nearest allies and also the sheets in the Dehra Dun herbarium which the writer is inclined to assign provisionally to this species are enumerated below :—

1. *Zizyphus hysudrica*, sp. nov. (= *Zizypus Jujuba*, Lamk., var. *hysudrica*, Edgeworth in *Journ. Linn. Soc.*, VI, 201-202, 1862). Leaves oval, broad-ovate to orbicular, glabrous or glabrescent below, nerves prominent above, petioles attaining 0·7 inch, frequently ¼ to ⅓ length of leaf. Usually armed.

Aitchison 140, 182, Rawalpindi ; Duthie 6,623, 6,624, Ajmer, 7,129 D. Ismail Khan ; Gamble 23,383, Lahore ; all in herb. Dehra Dun.

2. *Zizyphus Jujuba*, Lamk.

Leaves ovate or oval to elliptic, densely pale or ferruginous tomentose below, nerves depressed above, petioles very rarely exceeding 0·4 inch or ⅛ length of leaf. Usually strongly armed.

3. *Zizyphus Spina-Christi*, Willd.

Leaves elliptic to elliptic-lanceolate, glabrous or glabrescent below, nerves prominent above, petioles attaining 1·0 inch, frequently $\frac{1}{4}$ - $\frac{1}{3}$ length of leaf. Usually unarmed.

Zizyphus Spina-Christi, Willd., is believed to be sparingly cultivated in the Punjab and probably elsewhere in the neighbouring provinces. It is a widely distributed species, extending from Africa through Egypt, Arabia, Palestine, Persia, Afghanistan and Baluchistan to N.-W. India. The writer is inclined to assign provisionally the following sheets in the Dehra Dun herbarium to this species :—Lace 3,422, Sibi and a sheet without number collected at Ahmedabad and received from the Poona College of Science in 1893. Lace, speaking of the vegetation near Sibi (*Journ. Linn. Soc.*, 28, p. 294, 1890), says that this seems to have been "the only tree cultivated by the people near their villages until recently." This species in India is sometimes called *Z. Spina-Christi*, Lam. This is probably due to a confusion with an entirely different plant with a dry winged fruit, *viz.*, *Paliurus aculeatus*, Lam. = *P. Spina-Christi*, Mill.

Hasselquist thinks that *Zizyphus Spina-Christi* is the tree from which the crown of thorns was taken which was put on the head of our Saviour during the crucifixion, but the more general opinion is in favour of *Paliurus aculeatus*.

There is still another plant with glabrous leaves with which *Zizyphus hysudrica* has been sometimes confused, *viz.*, *Zizyphus Lotus*, Lam. This is a native of N. Africa and the Mediterranean region and it does not yet appear to have been definitely recorded from N.-W. India. The writer has seen no authentic specimens of this plant, but it is usually described as being a shrub (not a tree) with ovate-oblong leaves, not exceeding 0·5 *in.* long and with very short petioles which does not square with *hysudrica*. Moreover Edgeworth, after visiting Kew, distinctly says regarding *Z. hysudrica* "at first I had referred this to *Lotus*, but on comparison I find it is quite distinct." (*Journ. Linn. Soc.* VI,

201). *Zizyphus Lotus* is supposed to be the Lotus of the ancient Lotophagi :—

"The trees around them all their food produce,
Lotos the name divine, nectareous juice,
Thence called Lotophagi, which whoso tastes,
Insatiate riots in their sweet repasts,
Nor other home nor other care intends,
But quits his house, his country, and his friends."

Finally, it is interesting to note that Dr. J. L. Stewart combined *Z. hysudrica*, *Z. Lotus* and *Z. Spina-Christi* in a single species under the name *Z. Lotus*, Lam., while he kept *Z. Jujuba*, Lam., distinct as a separate species, thus emphasizing the differences between *hysudrica* and *Jujuba* which were somewhat obscured by Edgeworth's treatment.

From his actual description, however, it appears that the *Z. Lotus* of Stewart is mainly the plant defined in this paper as *Z. hysudrica*. Thus he describes the leaves of *Z. Lotus* as "broad-ovate (or oval), to orbicular * * under side often covered with white or yellowish tomentum or subglabrate * * petioles 0·2—0·5 *in.* * * fruit 0·5—0·6 *in.* long, smooth and black young, with age rugose, greenish purple or dark reddish brown," as against the following given for *Z. Jujuba* :—

Leaves "from oblong-ovate to nearly orbicular * * very closely tomentose under * * petioles 0·2—0·4 *in.* long * * fruit 0·7—1·0 *in.* long, dark brown or reddish yellow."

Of his *Z. Lotus* Stewart also writes as follows :—

"The plant here described is not uncommonly cultivated as single trees and in groves—perhaps the most common of the cultivated *ber* in some parts—all over the Punjab plains from Peshawar to Multan, and eastward to near the Jumna, in some places appearing to be wild or quasi-wild. It is common 'about villages' in north-eastern Afghanistan and reaches 3,500 ft. on the eastern skirts of the Suliman Range, Trans-Indus. * * It grows to be a largish tree with a trunk of 9—10 or at times 11 ft. girth and a broad, rounded crown to 40 ft. high, in habit and

general appearance much resembling *Z. Jujuba*, but its terminal branchlets do not appear in any case to droop. Its twigs are smooth and whitish with a reddish or bluish tinge, the bark of the trunk is lightish or dark grey,—in very old cases at times brown, furrowed with longitudinal wrinkles. The spines have often lapsed from the older branches. It flowers chiefly during the hot weather, the fruit ripening from September onward during the cold season. * * It probably yields much of the excellent fruit grown in special places, *e.g.*, about Pākpattan near the right bank of the Sutlej, to collect or eat which people will come a hundred miles."

Further specimens and observations likely to increase our knowledge of *Zizyphus hysudrica, Z. Spina-Christi, Z. Jujuba* and *Z. Lotus* and of the extent of variation in these species will be welcome at Dehra Dun.

The existing records of *Zizyphus Spina-Christi*, Willd., from the Indian region are as follows :—

Edgeworth (*Journ. Linn. Soc., VI*, 200) who says it is sparingly cultivated in the Punjab.

Lace and Hemsley (*Journ. Linn. Soc., XXVIII*, 314) who report it from British Baluchistan.

Boissier (*Fl. Or. II*, 13) who refers a specimen of Griffith's from Afghanistan to this species.

As Edgeworth and others point out, however, there are differences between the Indian tree and *Zizyphus Spina-Christi*, Willd., of Africa and Syria and it is possible that more complete material will show that the Indian tree, which is now provisionally assigned to this species, is really distinct. It is also possible that the tree now known as *Zizyphus Jujuba*, Lamk., in India will be found to be a distinct species from the common small shrub of that name (var. *fruticosa*, Haines), as has been suggested by Haines (*For. Fl., Chota Nagpur*, 1910, p. 270), and Parker (*Forest Flora of the Punjab*, 1918, p. 84).

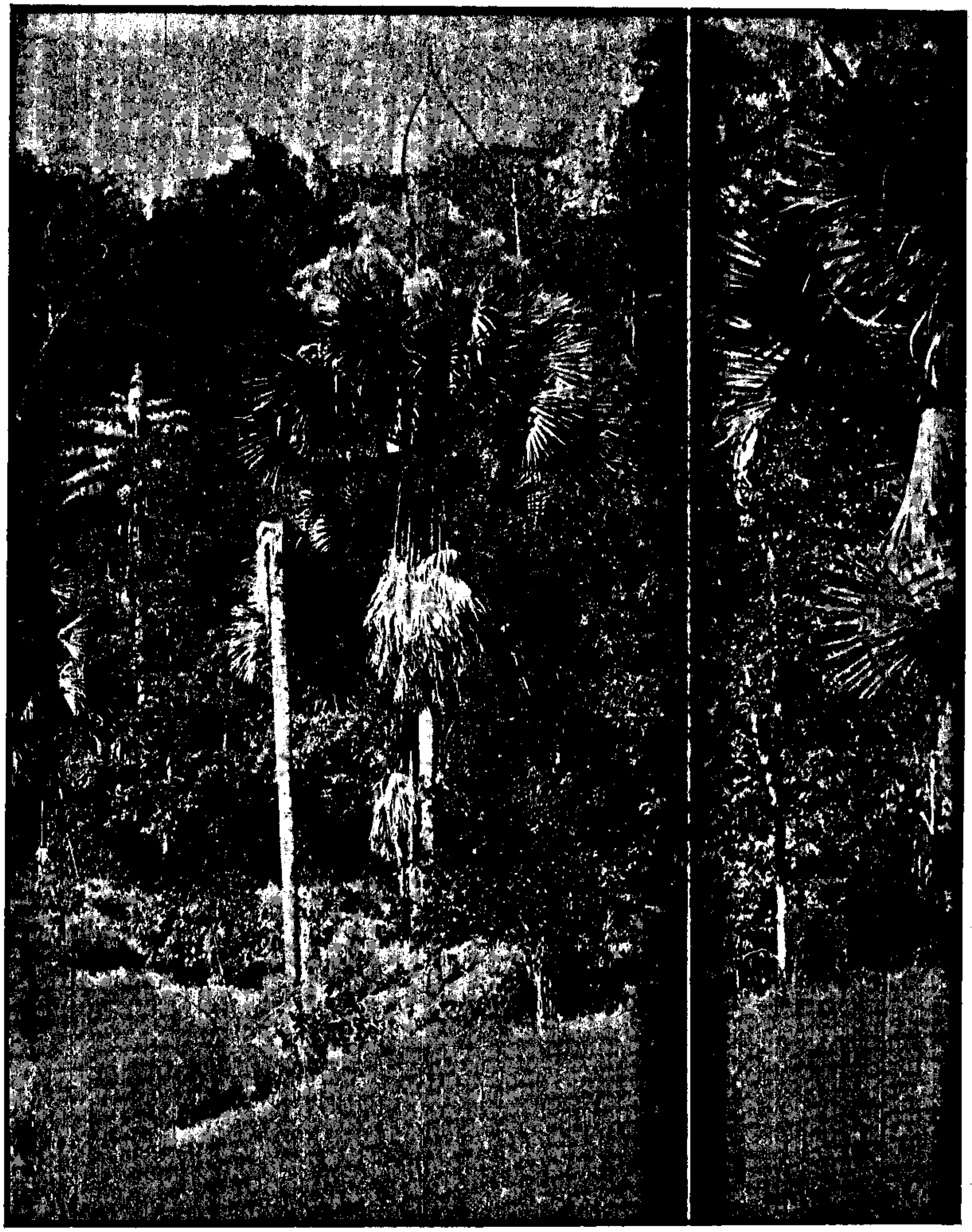


Photo-Mechl. Dept., Thomason College, Roorkee. Photo by R. R. Chandikar, Forest Surveyor.

FLOWERING CORYPHA

NOTE ON CORYPHA PALM IN NORTH KANARA.

The following notes taken from Mr. P. E. Aitchison's Working Plan for the Corypha Palm found in the Honnawar Forests in North Kanara, District Bombay, may be of interest —

Though the palm is found in small quantities in several localities in the district, its chief home is an area of 25,000 acres in the hills on the Western Ghats near Honnawar. The palm is gregarious and grows in patches varying from a few acres to large belts extending along a hillside. In some places the forest is pure, in other places the palm is mixed with deciduous species adjacent to evergreens.

When the palm flowers it dies. The age at which it flowers was found difficult to determine. It is a prolific seed-bearer and a single palm is said to yield over 560 lbs. of seed The seed is about the size of a marble quite round, horny, hard and smooth. It requires about six weeks to two months to germinate, very few seeds fail and seedlings appear in great abundance. One palm produces enough seed to stock several acres of ground. The seeds are washed down the hills and are also distributed over the forest by birds, squirrels and porcupine. *Deserted fields may suddenly* become covered with the seedlings. A few palms or clumps of palms may be found in flower every year, but a general seeding occurs at long periods.

By comparing the age of deciduous trees found on old Kumried areas, that is on areas cut over and burnt for shifting cultivation, the age at which the palm dies is found to be about 90 years. Though 90 years may be taken as the age of the tree when grown in favourable localities, the age at which it seeds would vary under different conditions and might be much less than 90 years in unfavourable localities.

The growth is at first very slow. The palm is valued by the Marathas and poorer classes for its pith which provides a useful food in the form of flour. This pith is found in mature trees only. The mature palms usually swell towards the centre portion of the stem and the local Marathas are able to discern which palms will

yield this flour and are fit to fell. A mature palm should yield at least 8 headloads of pith—many would yield twice this quantity if left to develop fully. The pith is generally dried in the sun or at times on a wooden platform over a fire. One head-load of pith yields about 30 lbs. of dried flour and the market value is 4 annas per maund of 28 lbs.

The young unopened leaves are used for umbrellas, the leaf being cut in half and dried. Full grown open leaves are used for thatching. The leaves are sold at Re. 1 per 100 as half leaves for umbrellas, or as whole leaves for thatching at the same price.

The leaves are cut from small palms and seedlings. Their removal seems to interfere little with the growth of the palm. The seeds are used as beads, buttons, etc.

NOTE ON THE PROSPECTS OF MANUFACTURING PAPER-PULP FROM HIMALAYAN SOFT-WOODS AT THE PRESENT DATE (JULY 1918).

BY WILLIAM RAITT, F.C.S., CELLULOSE EXPERT, ATTACHED TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

1. The woods referred to are Spruce and Silver Fir—white wood only.

2. The manufacture is that of ground or mechanical wood-pulp by the aid of water-power, either direct or transmitted electrically. Chemical processes are unsuitable in this country and need not be considered.

3. The essential conditions are a manufacturing site where raw material, power and a rail outlet for products can meet. Rail outlet, if not actually on the spot, should be within a few miles. Power required is about 70 H. P. per ton of dry pulp per 24 hours, 5 tons per day requiring, say, 350 H. P.

4. A considerable change has come over the prospects of this industry during the last four years. As a general rule if a raw material is of any value for any other purpose, constructional or manufactured, it is of too high a value for the paper-maker,

and these woods can no longer be regarded as little better than waste products. Other uses have been found for them which give them a value higher than their pulping value. Only the waste from these uses can now be regarded as having a pulping value. A similar revolution in values is happening with the corresponding species in Europe and America. Obviously, the result of this is to reduce the world's output of wood-pulp, Obviously again, this introduces a counter-balance in the shape of increased value of the product. The cost of imported mechanical wood-pulp, ex-ship Calcutta, early in 1914 was about Rs. 75 per ton. After war, when normal trading conditions are restored, it will not be less than Rs. 90 per ton—not enough to balance the revolution in values alluded to above, but enough to render possible propositions for pulping waste which previously were impracticable.

5. The waste referred to is the smaller ends, and logs too small to be worth saw-milling, say, from 8″ diameter down to 4″. If these are brought out of the forest, a considerable addition will be made per tree to the percentage of utilization. Also saw-mill waste in the shape of short ends, balks and blocks made in cutting sleepers, etc., to size and any other waste of this nature of 4″ cube and upwards can be so utilized.

6. When attached to a saw-mill, a pulping installation may be of comparatively small size, down to, say, an output of 6 tons dry wood-pulp per week. This would utilize about 8 tons per week of small logs and saw-mill waste.

7. The cost of such an installation depends largely on whether hydraulic power has to be developed for the saw-mill in any case. In such an event the additional power required for a pulping plant would cost comparatively little. If the saw-mill has a steam plant as well, which can supply steam for drying the pulp, another economy in first cost would be obtained. A rough rule is that where water-power and steam have to be provided *exclusively for pulp*, the capital cost is somewhere about Rs. 150 per ton of output per annum, but this is for large installations having pulp exclusively in view. The plants I am at present thinking of

are small ones as adjuncts to saw-mills. In such cases, assuming that hydraulic works providing a sufficiency of water for pulp have already been provided for the saw-mill and that only the additional turbines will be required and that a small steam drying plant must be supplied specially for pulp, then a rough approximate figure for the cost of a 6-ton per week pulping plant will be *Rs 30,000.*

8. The profit to be earned will depend largely on the locality and its position in respect of railway charges on product to market. I therefore deal only with the approximate gross profit earned at the mill. I assume a value of 3 annas per c. ft for the timber so used. Probably the mill waste should be taken at firewood value only. I also assume a selling value for pulp of Rs. 90 per ton at Calcutta and that there are no charges for supervision, this being provided by the saw-mill staff:—

		Rs	a.	p.
∴ 110 c. ft. timber at 3 as. per ft.	...	20	10	0
Labour for manufacture per ton pulp	...	6	0	0
Depreciation and repairs on plant. 10 per cent on Rs. 30,000. Output 300 tons per annum per ton	...	10	0	0
Cost per ton	...	36	10	0

leaving *Rs. 53-10-0* per ton of gross profit available for railway freight and nett profit. A rough average for railway freight to Calcutta is Rs. 20 per ton in Punjab and Rs. 25 in the U. P., and possibly this may be reduced by shipping from Karachi. There is, therefore, a prospect of a nett annual profit from such small installations attached to saw-mills of, say, *Rs. 9,000.*

The above assumes mill waste and saw-dust is available at no cost as fuel for drying pulp.

ZALOKKYI FOREST REST-HOUSE, MAIN BUILDING.

Fig. 1. Third day—shews the posts being erected by means of block and tackle.

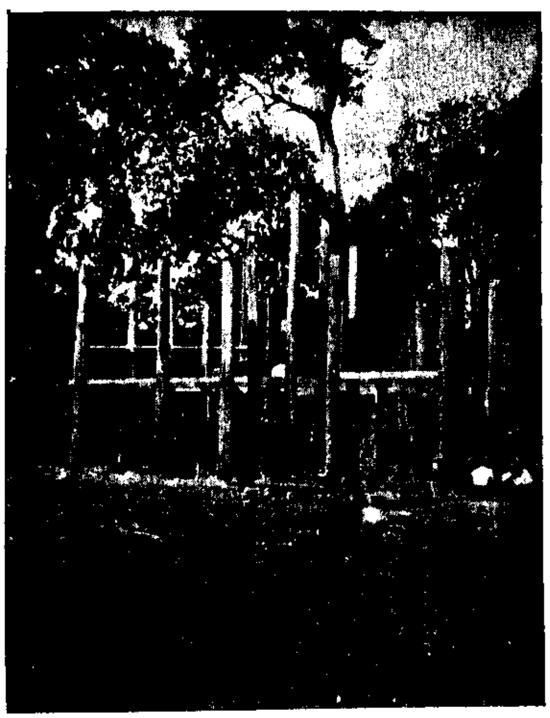


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Sixth day—shews the girders being put on and the scaffolding for the post plates in the course of construction.

Fig. 3. Eighth day—shews the post plates and tie beams being put on.

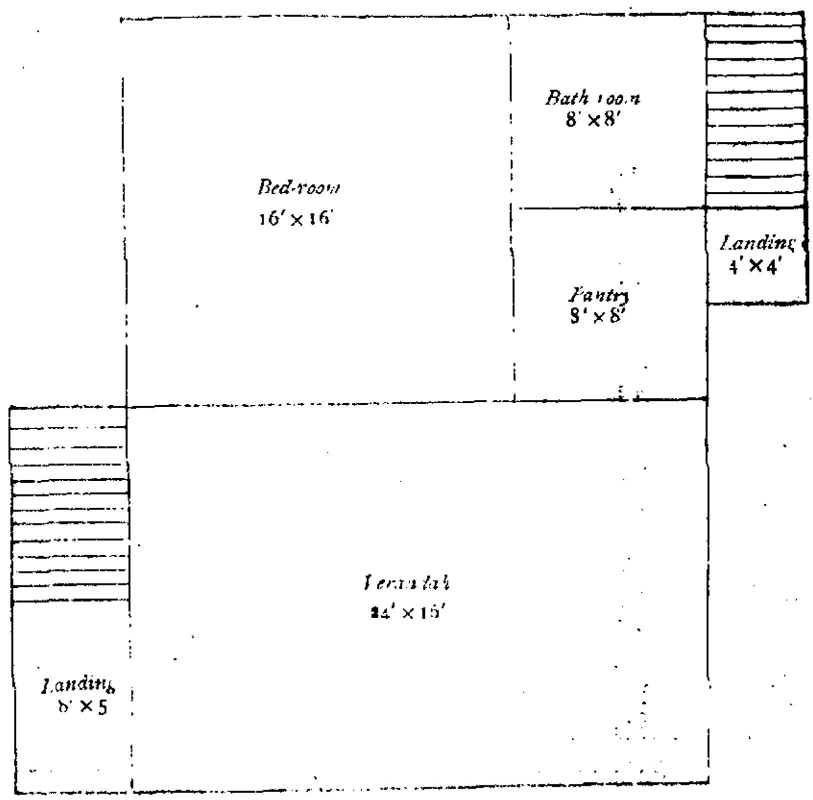
PRACTICAL ENGINEERING WORK AT THE BURMA FOREST SCHOOL, PYINMANA.

BY A. J. BUTTERWICK, P.F.S.

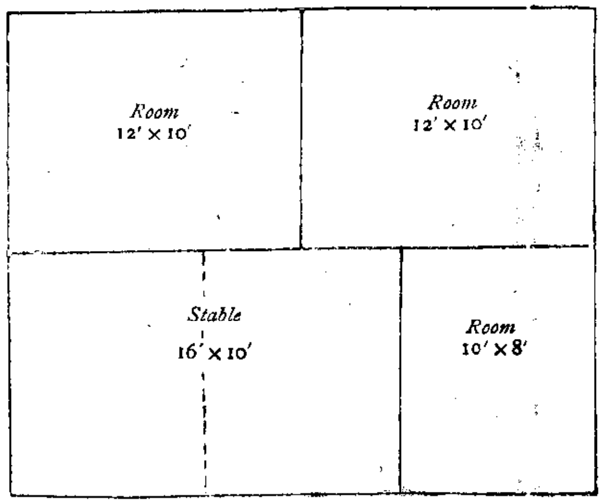
1. The attached series of photos (Plates 35 and 36) will be found of interest, as they show that the practical side of engineering is not forgotten in the Burma Forest School, Pyinmana.

A third class forest bungalow, according to standard plan, was required by the Pyinmana Forest Division at a camp called Zalokkyi, and the senior students of Forest School were asked to build the main building and servants' quarters. A plan of each of these is given below :—

Plan of Main Building (Scale $\frac{1}{96}$).



Plan of Servants' Quarters (Scale $\frac{1}{96}$).



2. Work was commenced on the 28th January 1918, and both buildings were completed on the 2nd February 1918. Not counting Sundays, there were thus altogether thirty working days. On account of illness, etc., a daily average of 28 students worked on the buildings. The hours of work were from 7 to 11 in the mornings and 4 to 6 in the evenings. Work on the main building only was done for the first eight working days, then on the servants' quarters only for the next three working days, and on both buildings simultaneously for the remaining nineteen days. With the exception of the clearing and levelling of the site, and the roofing of both houses, the students did the entire construction of the buildings themselves, including the pegging out and the digging of the post holes. The timber mainly used in both buildings was *Thitya* (Shorea obtusa), and on account of the unusually large amount of cup shakes, heart cracks, and other defects, which these logs were found to have, the posts, planks, and scantlings were found to be very unsound and liable to warp very badly. Great difficulty was accordingly found in making the different parts of the buildings fit strongly and accurately.

3. That this actual construction of buildings bridges, and roads is of paramount importance in any instruction in engineer-

ZALOKKYI FOREST REST-HOUSE, MAIN BUILDING.

Fig. 4. Eighteenth day—shews the hip rafters being put up.

Fig. 5. Twenty-first day—shews the purlins being put up.

Photo-Mechl. Dept., Thomason College, Roorkee.

Fig. 6. Twenty-fourth day—shews the wagat roofing being put on. Some students are laying the floor planks on the joists.

Fig 7. Thirtieth day—shews the completed main building.

ing, has been found from experience by the writer. There are a thousand and one things which one learns during the construction which can never be obtained from even the best text-books. Even the apparently simple operations of pegging out the plan of the building or bridge, and putting in the posts, some of which are well over 30′ long, are much more tricky than one is apt to think.

4. The erection of a building or bridge has, therefore, been entered as one of the most important items in the curriculum of the Burma Forest School. In this connection it will be interesting to note the different important engineering works done by the students for the last five years:—

In December 1913 ...	Made 81 reinforced concrete boundary pillars for the elephant fodder reserves at Yeni.
In February and March 1914.	Erected a students' barracks 120′ × 20′ at Ainggyé.
Lecture term of 1914 (Saturdays).	*Erected a wire-rope suspension bridge* 200′ long for foot traffic over the Ngalaik Chaung at Pyinmana.
In February and March 1915.	Constructed a second students' barracks 120′ × 20′ at Ainggyé.
In July and August 1915.	Constructed a mitre joint, or straining beam, trussed bridge 20′ span at Ainggyé for cart traffic.
Lecture term of 1915 (Saturdays).	Made over 200 reinforced concrete blocks for a well for the School recreation ground; also put up a rough single lock bridge 35′ span for foot passengers in the School compound.
In February and March 1916.	Constructed a N trussed bridge of 40′ span over the Thetha Chaung at Padaukkon, the biggest scantling used being 15′ × 9″ × 3″; also made at the same place, a simple girder bridge 12′ span over the Gwedauk Yo. Both the above were for cart traffic.

In February and March 1917.	Constructed a simple girder bridge of 24′ span for carts over the Monhnit Chaung at Monhnit.
In February and March 1918.	Put up a third class forest rest-house and servants' quarters at Zalokkyi.

Besides the above major works, the students have done the usual road alignment and road construction, including the erection of sleeper and other culverts, Irish bridges, and pole drains.

SIMUL PLANTATION IN JHUMS IN ASSAM.

BY R. N. DE, PROVINCIAL FOREST SERVICE.

1. Simul (*Bombax malabaricum*) is found abundantly in all the alluvial formations of the Lakhimpur and North-East Frontier Districts. It is a pioneer tree and comes up plentifully in alluvial formations in these parts. Due to the luxuriant growth of the evergreens that come up afterwards on those formations, the subsequent regeneration of Simul is altogether stopped: the seeds either do not reach the soil at all, or if they do, can neither germinate nor grow under the evergreen cover. The result is that we have huge Simul trees here and there in these forests, surrounded by evergreens, with no Simul reproduction at all.

2 In the districts above-mentioned, there are altogether five saw-mills working for making tea-boxes. Of the tea-box trees, Simul is the most abundant and important one, though other soft-wooded trees are also used. As the saw-mills are gradually working Simul, there will be a total absence of this tree in these parts, unless it is propagated. Hence the necessity of plantations to continue the supply of Simul.

3. The Simul may be put to other uses in the near future beside making tea-boxes. Recent experiments on its suitability to make cold storage vans have given favourable results, and it has been found to be a better insulating material than even cork; in the vans under experiment the insulating material used was Simul. The temperature of the vans was reduced by ice from 90°F. to

Photo.-Mechl. Dept., Thomason College, Roorkee.

Terminalia myriocarpa 46'-4" in girth round buttress, killed by fire, in burning *jhums*.

42°F. in 24 hours. The heat leakage or rate at which the temperature of the vans increased on the exhaustion of the ice supply was 1°F. in 4 hours (*Indian Daily News*, 16th October 1917).

4. In order to reproduce Simul, attempts were first made to plant it in lines, in grass areas. The plants were put out from nurseries, but the method was expensive. Continual cutting back of the grass was necessary, as otherwise the young plants were choked; in addition, a large amount of damage was done by wild elephants, which, finding a cleared line, promptly used it as a path with disastrous results to the Simul. Broadcast sowing was also attempted without success.

5. In these parts there is a jungle tribe called the "Miris" who practise jhumming, *i.e.*, shifting cultivation. They clear jungle at the beginning of the hot weather and then set fire to it. This firing is responsible for the death of many large forest trees. (Plate 37 shows a hollock tree—*Terminalia myriocarpa*—46′ 4″ in girth killed by fire.) They cultivate the "jhums" for two successive years, rarely three if the soil is exceptionally good, and then let it lie fallow for about ten years, after which they come back again to "jhum" the same area. The staple product they cultivate is rice. Advantage is taken at present of this practice to spread Simul.

6. The system adopted is as follows :—

Early in June or July varying according to the time when the Simul seed ripens, it is collected by the Forest Department and distributed to the villagers who, at this time of the year, sow rice in their newly cleared "jhums." Before the rice is sown they have to put up stakes in their "jhums" at 26′ × 26′ and then the rice is sown with the Simul seed, the latter at each stake. Sometimes the rice is sown before the Simul. Five to ten seeds are put at each stake; this is done to be perfectly sure that there will be no failure. In some cases the staking is done under the supervision of Forest Officers, but in the North-East Frontier District, the "Miris" do it themselves under the instruction of Forest Officers, as the Forest staff is insufficient to do the staking in a number of villages, scattered over a considerable area. If the seeds are good, they germinate

freely within six or seven days. Though Simul does not grow so quickly as the rice plant, it is not at all injured by the latter. If, at any stake, no Simul seed has germinated, seedlings are transplanted from those stakes where there are more than one.

7. As the transplantation is carried on, only the best seedling is kept at each stake and the rest are transplanted if necessary, or removed. After the rice has been cut, the area is cleared and mustard, rye, potato, etc., are grown in the jhums. By this time the Simul plants are 1′—2′ high. Next year in the rains, the rice is sown again after clearing the area of weeds, and this rice is weeded once or twice during the rains. In the rains, the Simul plants grow very vigorously, some of them attaining 6′ in height Having received such careful tending from the very start, no amount of weeds and fast growing shrubs can hinder their growth and by the winter of the second year most of the plants are 8′ and over in height; Mr. Jacob, Deputy Conservator of Forests, has measured seedlings which have attained 15′ in height in their second cold weather. The Miris usually abandon their jhums at the end of the second year after growing mustard, etc. The plants now need no looking after and can fend for themselves, but if the land is cultivated for the third year, the plants do still better. The Miris can grow crops underneath Simul without difficulty, as it has a very light crown.

(Plate 38 shows a Simul jhum in its second cold weather.)

8. As from its habit, Simul does not grow any more branchy when isolated, and as the height growth of this tree is not appreciably stimulated by growing the plants closer together, thinning and cleaning operations are unnecessary. It was found that when planted 12′ × 24,′ branches were interlacing by the third year; this is why plants are put in 26′ × 26′. Much knowledge has yet to be gained as to the best distance at which plants should be spaced. Sample plots have been laid out in the Lakhimpur District to ascertain the rate of growth of Simul.

9. The Miris of the North-East Frontier District who plant Simul in their jhums are given one first-class tree free for a dug-out, per house, once in four years and are paid Rs. 4 per 100

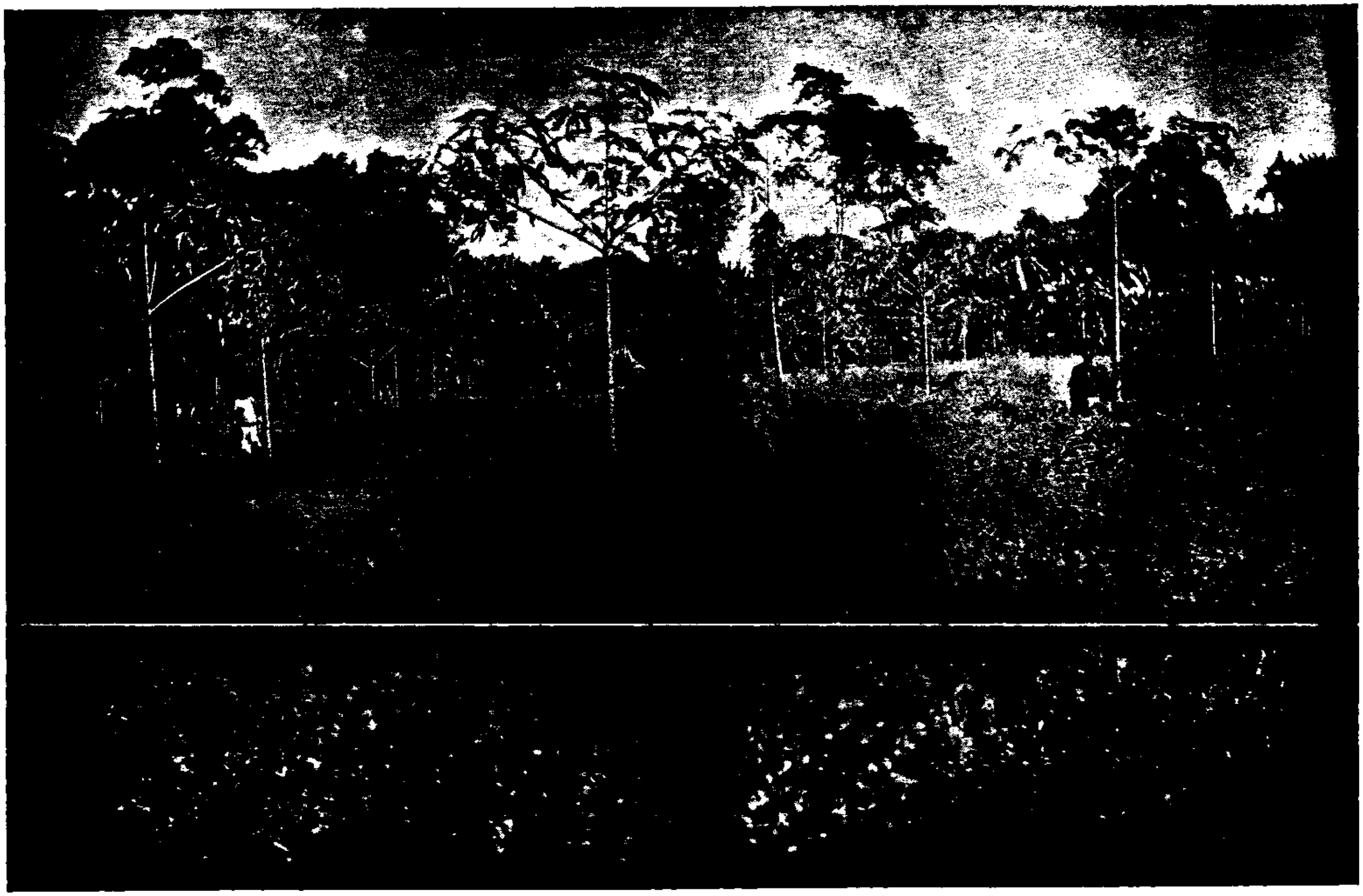


Photo-Mechl. Dept., Thomason College, Roorkee.

A Simul *jhum* in its second cold weather.

seedlings which are 8′ or over in height, in the cold weather of the second year when the counting is made. One bola tree (*Morus* sp.) is also given free to every 20 houses for making oars. In the Lakhimpur District, Miris are allowed the privilege of "jhumming" inside the Dibru Reserve, the area, where jhumming is to be permitted, being selected by the Forest Department. They are not entitled to any trees and no payment is made to them, as the jhumming inside the Reserve is itself a great concession ; the more so, since they have nearly exhausted all forest lands near their villages.

10. The system is working quite satisfactorily in Lakhimpur and the North-East Frontier Districts, where many areas formerly unstocked or stocked with useless species are now getting filled with promising Simul plants. In the North-East Frontier District there were some 450 acres under Simul in 1916-17. Many seedlings have been damaged and even killed by floods during the rains in the low-lying areas. The low-lying "jhums" have, therefore, been excluded as unsuitable for Simul. It has been estimated at present that Simul will take 25 to 30 years to attain 6′ girth, which is a suitable size for conversion. Some saw-mill managers are of opinion that 4′ girth is more convenient for making tea-boxes in their mills, but the wood of such trees is likely to be spongy.

11. Up till now no serious damage has been done to the young seedlings by animals or by insect pests, but the plants are freely browsed by deer, etc. The writer has, moreover, seen cases of damage by Longicorn larvæ, and has sent specimens to the Forest Zoologist for breeding and identification.

Identified by Mr Beeson. F.Z. as Glenea spilota, Thoms. (Family. Lamiidae.) MBn

FLOWERING AND AFTER OF *BAMBUSA ARUNDINACEA.*

BY K. GOVINDA MENON, CONSERVATOR OF FORESTS, TRAVANCORE STATE.

All the authorities are more or less agreed with regard to the periodicity and gregarious flowering of *B. arundinacea.* Gamble says with regard to *Bambuseæ* that "in a few species they come annually, in most they come at long intervals and then all the

clumps in a locality flower together and seed and die." Bourdillon divides bamboos with regard to their habit of flowering into three great classes, *viz.*, (*a*) those which flower annually or nearly so, the flower panicle terminating leaf-bearing culms; *e.g.*, *Ochlandra Rheedii*; (*b*) those which flower gregariously and periodically, all culms of one clump and all clumps in one district flowering simultaneously. The culms die after ripening their seed and usually the underground rhizome also dies; *e.g.*, *B. arundinacea*; and (*c*) those which flower irregularly, one or a few culms in one clump or a few clumps in one locality flower together, while at other times there is a simultaneous flowering all over the district; *e.g.*, *D. strictus.* Periodic and gregarious flowering of *B. arundinacea* is hence an established phenomenon.

In 1918 March—April, most of the bamboos of the above species in the Thekkadi leased forests of the Tunacadavu Range are reported to have flowered and seeded. In the adjoining private forests no bamboo has flowered at all. In the Cochin State Forests which touch the leased forests on the western side *one* solitary clump of *B. arundinacea* flowered and seeded. No other clump has seeded anywhere close by though the whole forest is full of bamboos. The solitary clump which flowered is about two miles as the crow flies from the leased forests where the bamboos have flowered, and this clump was bodily pulled down by wild elephants and the panicles eaten up. After the advent of May showers, small leafless shoots came up from the rhizome of this clump and all these shoots ranging from 1′ to 3′ in height flowered and seeded by the end of June.

Two conclusions are deducible from the above :--The flowering of *B. arundinacea* is not necessarily gregarious but may be solitary. (2) The reserve materials in a flowering clump of *B. arundinacea* left behind in the rhizome, if any, are not fit to be utilized for developing leafy shoots but for giving rise to shoots which must at once flower and seed; possibly due to the absence of an enzyme required to reconvert the reserve material into a suitable form for the production of leafy shoots. But this requires further investigation.

"MI-DO:" THE TALE OF A HAING.*

BY J. D. C.

"SIR,—I was out searching for my buffaloes this evening when I met the 'haing-gyi' who at once chased me and I only escaped by climbing a tree and waiting till he moved off." The words were spoken in Burmese by an elderly contractor employed at the time in dragging logs to a forest saw-mill near by. I was disturbed in a deck chair gazing into a camp fire, thoughts thousands of miles away in the West Country as they are apt to be at this time of day or rather night when one feels fed up with one's own society after a long spell in the forest. By the light of a half moon to go out after a rogue elephant held no attraction for me, so I told the contractor to go out early the following morning to look for tracks; and if he found them or the animal reasonably near, to come back and let me know. I had first heard of this haing when I came to the division nearly five years ago, since when he had, to my knowledge, killed three people, chased the D. F. O. when riding along a cart-track narrowly missing the breakfast coming on behind, charged another forest officer in spite of three dogs and several camp followers being with him, and had frequently delayed dâks by holding up the runners. With the local Burmans he had a very evil reputation as, in addition to killing the aforesaid solitary travellers, he was in the habit of lying in wait for carts and people returning from 'taungyas' with paddy and other produce, frightening the people who immediately abandoned their loads whereupon the haing would help himself at leisure to the luxuries thus within his reach. He was said to be peculiarly partial to tomatoes, and once walked through a camp helping himself to these and other vegetables without doing further damage. For years he had been regarded as a dangerous rogue and many have been the attempts on the part of forest officers to bag him. On one occasion he is alleged to have been hit by a charge from a 4-bore which bowled over the operator but

*Haing is the Burmese term for a "makna" or tuskless male elephant.—[HON. ED.]

not the intended victim, and, in spite of numerous other undoubted hits, he seemed to bear a charmed existence. This fact must be largely attributable to his habit of never staying for any considerable length of time in one place, so that if heard of at a particular spot one day he was quite likely to be ten miles away by the next. All sorts of damage was put down to his account and, whenever any unusually large tracks were seen, it was always presumed he had made them.

However, haing or no haing, my sleep was not disturbed that night. Nor the following day did I think of him, except once whilst out at work hearing a crashing in the undergrowth I realized I had no gun, only to find that it was my terrier chasing buffaloes. At half past twelve when I had finished breakfast and was just about to settle down in a comfortable chair to spend an hour grappling with home politics, the National Review as my mentor, up the verandah stairs walked the old contractor and I knew my hopes of a restful afternoon were no more. After tracking for most of the morning, he said he had located the elephant in some dense evergreen not more than a mile away. As I didn't know the man, I decided not to entrust him with a spare rifle, so took my ·450 only. The one mile turned out to be three before we got on to the tracks in cool shady forest along the head-waters of a nearly dried-up stream. Passing on the way several field huts and saw-pits, I noticed the retinue of followers steadily growing but refrained from saying anything until we were on the tracks. The old tracker had seen them too and without any hint from me now turned round, picked out one with a good knife, told him he could follow and the rest to sit down and wait till they heard a shot. From this moment on he went up in my estimation, and later I found out he was an experienced elephant tracker. In about half an hour, after getting through some bad places including cane-brake fairly quietly we heard the animal smashing bamboos close ahead. Tracking then became exciting work, we being on the side of a steep slope with the elephant at the bottom about 100 yards further along. The slope now became much steeper and was covered with thorny undergrowth as well

as dead leaves which are difficult enough to get quietly over without other obstacles. The tracker was making as much noise as I was, perhaps more, so I pulled him up but he merely said it didn't matter as the haing was not afraid of people. I explained to him that that might be quite true if it was the big haing, but I wanted as good a shot as I could get and was not at all keen on going further than was necessary nor did I want a shot at a charging beast in dense jungle. A short way back I had seen fairly clear tracks in the sandy stream-bed and they did not appear so enormous as on other occasions. Being told I would not shoot unless it was the big haing, the man didn't mind at all as he was quite positive of the animal's identity. What wind there was seemed to be downstream, so we climbed the slope we were on, dropped a few feet the other side and went on fast. Then having gone just about far enough to head the animal off, we crossed over the top slowly and got down quietly to within about 40 yards of where bamboos were still crashing. I now got a glimpse of the tail which was a broken off stump with no sign of a brush, and at last I felt quite sure it was "Mi-do" (Burmese for "Short-tail"). Shortly before I thought I had heard the ominous clinking of a chain and the unpleasant prospect flashed across my mind of walking up to a dead tusker with a big C* or SB on the rump and a few feet of tethering chain on one leg. My provident fund would have been required in such an event. Again the tracker cheered me up by saying he could hear no chain and that it must have been some bird. One has always to bear in mind, however, that even the best Burman tracker is out for meat rather than sport or rupees. Having seen the stump of the tail as already mentioned, I had no further doubts. Both of us now got up to a tree some ten yards nearer and then I had to wait several minutes, probably not as many as they seemed, before getting a chance at a head or ear shot. I got the latter and he staggered as soon as I had fired and began to fall slowly, but I was taking no risks with a beast of his reputation and hit him a second time in nearly the same spot before he rolled over. He struggled on

* *Note.*—Timber firms in Burma invariably brand their working elephants.

his back with his four legs kicking wildly in the air, lashing his trunk about furiously, gurgling and taking very long deep breaths. He was an extraordinary sight in this position appearing even more huge than when on his feet. The noises and lashing of the trunk continued, so I crept up closer to put him out of pain, but on seeing me he made a mighty effort and righted himself. Two shots more made him sink slowly into the crouching position that trained elephants assume before being loaded with baggage and, in this position, he remained motionless, the mass of his body completely hiding one hind leg from view. He was in splendid condition, being paddy-fed as one of the Burmans remarked, and measured 4 ft. 6½ ins. round the fore-foot which would make him just over 9 ft. in height (the biggest baggage animal in this division measures 7 ft. 6 ins.). After I had shot him I felt quite sorry at having deprived such an immense and magnificent beast of life. The Burmans did not feel the same, crowding on to his back like a lot of children in the gayest of spirits and few failed to inform me he was a man-killer.

The camp spent the whole of the next day cutting up the carcase, villagers flocking in from miles around assisted in the work and there were no coolies for the saw-mill nor sawyers for the saw-pits that day. The old Burman estimated that 150 villagers carried off at least 20 pounds of flesh apiece: delighted as they were at getting rid of a much-feared enemy, the prospects of a flesh feed caused them just as much pleasure. Elephant tail makes good soup; the meat is like coarse and rather flavourless beef but edible as a change from the eternal chicken. Of the enormous quantity of flesh on an elephant, not a particle is wasted by the time the cutting up is finished. It is all carted or carried away within twenty-four hours, and is afterwards cut into small strips and hung on lines in the sun to dry. Though several men were left to camp near the carcase overnight, the guard was not efficient, the trunk having been hacked off and stolen before daylight. The finger at its tip is invaluable in Burmese medicine. Getting the flesh out of the feet is tedious business and hacking through the bone with an axe quickly destroys all edge. As a

temporary preservative I had the cleaned feet stuffed with a mixture of wood-ash and sand.

The fearless manner of the old tracker armed only with a knife struck me as admirable: any Government reward on the haing I am recommending be paid to him.

FIRST MEETING OF THE BOARD OF INDUSTRIES, INDUSTRIES SECTION, CAWNPORE.

After the reorganization of the Board of Industries the first meeting of the Industries Section was held at Cawnpore on the 27th July 1918.

Among other matters, the Board considered the proposal of the Director of Industries regarding the working of the Central Emporium, Cawnpore the appointment of a die-sinker and tool maker—and the utilization of Rs. 10,000 sanctioned for experiments in tannin and other dye-extracts. The following subjects were recommended for the award of State Technical Scholarships for the year 1919:—

(1) Wood-distillation.

(2) Electrical Engineering.

(3) Dyeing of textile fabrics.

EXTRACTS.

BURMA FOREST SERVICE.

TO THE EDITOR, "RANGOON GAZETTE."

SIR,—From the Burma Quarterly Civil List ending July 1918 it will be seen that owing to the war, eleven deputy commissionerships and eleven district superintendentships of police are now held by provincial service men, whereas the pre-war regulated figure was two for each service. Similarly in the judicial branch, in the P. W. D., in the medical service, and in the educational department, all the appointments rendered vacant by the departure of the imperial service occupants on active service have been filled up by the promotion of provincial service men. Further, daily as more imperial men are being called out on military service, more provincial men are being promoted to the vacant posts. A large percentage of these promotions have been given to Burmans too. The only service in which this liberal and justifiable procedure has hitherto not been followed is the forest service in Burma, and Burma only; for, in the other provinces in India, provincial forest men have been freely given the vacant charges previously held by imperial men. A fairly large percentage of the latter have gone on military service, and many more are about to go. Also recruitment to that service from home has ceased for some time now. In spite of these facts, the provincial forest men in Burma have been given only one additional divisional charge since the war started. The forest powers that be, rather than give the provincial men the vacant charges, have doubled up the divisions, and placed two under one divisional forest officer, generally an imperial man. For example, the D. F. O., Pakokku division, is also managing the Minbu division, the D. F. O., Katha division, is similarly running the Myitkyina division as well as his own, and the personal assistant to the conservator of forests, Pegu circle, has been given, besides his onerous duties in the secretariat, the control of the Insein division as well. The same powers that made these appointments stated in every annual report before the war that the divisions in

Burma were much too large, that the D. F. O.'s were understaffed and overworked, and that the work was rapidly increasing in volume annually. It seems very paradoxical that now, although the staft has been very heavily depleted owing to the number of men on military service, and although the work has increased three-fold with the supply to the military of timber, these same forest powers are placing two large divisions under one officer with a smaller staff. This one officer, however energetic and capable he may be, cannot possibly run two divisions with their concomitant offices efficiently, and it means one of two things; either one or other division is being totally neglected, and the subordinates and clerks in it are getting very out of hand; or both divisions are being insufficiently controlled. Incidentally these dual charges are costing Government a tidy sum of money, for each officer who holds such a charge gets a sum of Rs. 100 added on to his pay. Further, it also means a lot of time wasted, as the same officer has to travel about needlessly from one head-quarters to another. If eleven provincial men, the most of whom are Burmans, are considered fit by the Local Government to be deputy commissioners of most important districts, surely there must be more provincial forest men at present in subordinate charges who could well hold charge of forest divisions There is not a single Burman in charge of either a forest division or even of a forest sub-division. Looking up the same Civil List, it will be seen that there are nine extra-deputy conservators of forests, with services varying in length from 19 to 26 years, holding subordinate charges. There are also several extra-assistant conservators of over 15 years' service, who are yet in subordinate positions, whereas their more fortunate forest college confréres, serving in India, have long been holding divisional charges. Regarding the E. D. C.'s, the following extract taken from the resolution of the Government of India in the department of revenue and agriculture, No. 17F. 77-33, dated Simla, the 23rd June 1911, will be of some interest:—

2. (ii) Extra-Deputy Conservators.—"No officer may be promoted to the rank of E. D. C. unless the Local Government considers him fit to hold a major charge; and except for special

reasons an E. D. C. should be actually placed in a charge classed as major."

As the above-mentioned nine E. D. C.'s have been promoted to their grades by the Local Government, it follows that the Local Government must have considered them fit to hold major charges; and, according to the very clear orders quoted above, they should be given major charges, especially now when there are a lot of vacancies. No one can learn to control and administer unless he be given a good early chance to do so; and no one who has not been given such a chance, should be condemned as unfit. Also any man, however able he may be, if he be kept down in a subordinate, irresponsible capacity for a very long part of his early career, will lose that sense of responsibility and self-confidence which is a *sine quâ non* for efficient control and administration and he will never be a success in a superior appointment. In view of the excellent, broad-minded, and statesmanlike speech delivered by the Lieut.-Governor in the recent durbar held at Rangoon it is to be earnestly hoped that the egotistical and parochial policy which appears to have hitherto characterized the administration of the forest service (and no other) in Burma, will be abandoned and every encouragement and advice be given to the provincial men to enable them to become efficient administrators. Also this encouragement and advice should be freely given as well to the younger promising provincial forest officers, as they are in the most important periods of their careers.

Yours etc.,

NOUS.

[*Rangoon Gazette.*]

[We understand that there are 22 Provincial Forest Officers who joined the service before October 1904 in the Civil List referred to. Of these 11 are now in charge of divisions, one is at the Pyinmana Forest School, one is in the Andamans, one is on leave and eight are doing Assistant's work.—HON. ED.]

FOREST GRAZING AND THE NELLORE "KANCHA" SYSTEM.

BY CECIL E. C. FISCHER, DISTRICT FOREST OFFICER, NELLORE.

THE grazing of cattle in the forest is admitted to be a detrimental practice from almost every standpoint. Apart from the injury to the forest itself, and thereby to the dependent interests, it has all the objections of promiscuous and communal grazing.

These facts and their remedies have been urged for a long time by foresters in India, but very little weight has been given to their opinion which are generally looked upon as highly coloured, and biased. It is only recently, at least in the Madras Presidency, that steps towards an intelligent policy of improvement have been taken. How far this has come about through the insistence of forest officers it is difficult to judge, but it seems clear that more attention is accorded to the opinions of others on the subject. It will be useful, therefore, to quote the words of an agricultural officer who has expressed the gist of the matter more eloquently than I can hope to do. In his report on his Cattle Survey of the Madras Presidency, Mr. H. C. Sampson wrote: "It is a noticeable fact that the nearer cattle are to the forests, the more degraded the type. Here one sees all the evils of mixed grazing ....Forest grazing is always a serious menace to the forests and not only to the forests but to the water-supply of wells and tanks . ...Grazing and forestry are, and must be, at variance ; for, as the forest canopy increases, the grass tends to disappear and the simplest way of lessening the shade and increasing the grass is by forest fires."

It is not necessary to dwell further on either of these two aspects of the evil.

Unfortunately, in most parts of India, at all events practically throughout Southern India, it has been customary for the people to send at least their inferior cattle to graze in the forests, and no sudden stoppage of this practice could be contemplated.

In some parts of the world some kind of compromise has been arrived at and a silvo-pastural system has been evolved

under which the growing of trees and the production of fodder-grass go on side by side. But it is only a compromise and, moreover, premises the most favourable conditions of climate and human co-operation. All these circumstances are absent in India, nor could even the human co-operation be hoped for short of a considerable period of education.

In order to devise remedial measures it is necessary to understand thoroughly the routine of the objectionable practices. Where some attention has been paid to the breeding of cattle, the breeders themselves have introduced restrictions. There the better class of cattle are stall-fed, or at least carefully segregated and grazed on the land in numbers not exceeding the feeding possibility of the area. In other localities, and in even these as far as the excess cattle maintained for manure or for the prestige of ownership is concerned, there is no such restriction. The number of cattle is far in excess of that which can find sustenance on the land. Large herds have to find what food they can, with the deplorable results inseparable from communal and excessive grazing.

To add to the disastrous position, that unsavoury enemy of vegetation, the goat, until recently was rampant. It is only within late years that this animal has been excluded altogether from Government forests.

The remedy for this state of affairs lies clearly, firstly, in the reduction of what may be termed the "drone" cattle to reasonable limits and the segregation of the different classes so as to avoid the evils of promiscuous breeding; and, secondly, in providing ample fodder for all.

There actually has existed from before the days of the British occupation an indigenous practice of this kind in the Nellore District, and this has given a direction for the policy of the future.

The Nellore District forms a comparatively narrow belt along the Bay of Bengal stretching for about 140 miles, starting about 40 miles north of the presidency town. On the west it is bordered by a low chain of mountains known as the Veligondas. Between this range and the sea, a distance of 50 to 60 miles, spread plains dotted with hills of gradually diminishing elevation and furrowed

by numerous rivers and streams. Near the coast and adjoining the many tanks, there are stretches of rich arable soil, but by far the greater portion of the area consists either of ocean sands, dry gravelly or quartzose soils of small fertility. A fair proportion, including most of the hillocks, is occupied by so-called forests. These are of the poorest type and are made up mostly of thorny shrubs such as *Carrisa spinarum*, Randias, etc. They present ample evidence of the goat-browsing, over-grazing, and ruthless hacking of the past. Such are the areas in which the forest officers, until recently, have been inhibited from imposing salutary restrictions in the direction of limiting the number of head to the available supply of fodder, with the result that the areas have been further degraded instead of being improved after being brought under forest reservation.

It is perhaps a matter for surprise that this district is the home of the famed Nellore or Ongole breed of cattle and that so fine a breed could be raised alongside the desolation I have attempted to depict. But the best class of cattle are bred mostly in the coastal tracks where they are either stall-fed, grazed on the fields when lying fallow, or pastured on private lands earmarked for the growing of fodder under the strictest surveillance. It is only the miserable excess cattle, and of course the goats, that are responsible for the injury stated.

The areas reserved for the better cattle are enclosed within fences and are known locally as *kanchas*. They are given a period of rest during part of the year and only a strictly limited number of cattle is admitted at other times. The period of rest coincides with the time when, after the break of the south-west monsoon, the new grass is growing and the fields are not yet under crop, so that the latter are available for pasture. By the time the cattle must be driven from the fields the *kanchas* are ready for them, to be closed again when the stubble left on the fields after the harvest invites them afresh.

Owners of such grazing blocks who are in a position to admit the cattle of others demand high rates for the privilege. The fallow areas in the wet land tracts are insufficient for all the cattle

when the fields are closed to them, and there sets in then a temporary emigration towards the hills, the beasts returning only after the harvest.

This is the "Kancha" System which, during the past three years, has been extended to practically all the Government forests in the plains of the district. For climatic and irrigational reasons the slopes of the Veligondas have not been included in the scheme, the hills are closed to grazing and the cutting and removal of grass alone is permitted. The plains forests have been divided up into blocks of convenient size, varying from 60 to 3,000 acres. Each block or *kancha* is put up to auction in May for the ensuing grazing season at an upset price of 4 annas per acre. As far as possible the village limits are adopted as the boundaries of the blocks so as to induce the village as a whole to purchase the lease for the use of the village itself. Here and there speculators take up a block or two with a view to making a profit on the migrant herds from the wet belt, the owners of which are willing to pay a comparatively high rate for ensured and safe pasturage of their valuable cattle.

The *kanchas* are handed over to the purchasers on the 1st July although they remain closed to grazing for another $2\frac{1}{2}$ to 4 months according to seasonal variation. When grazing starts, the incidence is limited to one head of horned cattle (bulls, bullocks, cows, and buffaloes) for every two acres or one sheep per acre. It will be seen, therefore, that the grazing costs at least 8 annas per head of horned cattle or 4 annas per sheep. The majority of the *kanchas* sell for 4 annas per acre or a trifle more, but a considerable proportion, owing to local conditions and competition, fetch a good deal more, culminating in one instance at Rs. 4 per acre. This rate is in extraordinary contrast with the nominal fee of 3 or 4 annas per cow or bull, 6 annas per buffalo, and $1\frac{1}{2}$ or 2 annas per sheep, which was the grazing fee for the whole 12 months under the old system of unlimited grazing on individual permit.

From the date of opening the *kanchas* may be grazed upon until the end of April, after which they are closed again just before

the first premonitory showers before the monsoon are expected. Sheep are not admitted simultaneously with horned cattle, but only after the latter have quitted late in the season.

An important feature of the system lies in the fact that the protection of the *kancha* against malpractices of all kinds is left almost entirely to the lessee, who is directly responsible and may be fined or even have the lease cancelled should he default in this matter. The lower subordinates of the Forest Department are forbidden to interfere in any way, except to assist at the direct invitation of the lessee.

With some of the blocks, in addition to the area open to grazing, the lessees undertake the protection of adjoining areas that are closed for regeneration or for other reasons. For the successful protection of these closed areas the lessee is permitted to cut and remove grass or in lieu is entitled to a rebate of one anna per acre so protected.

In recognition of their efforts the lessees whose protection has been effective, receive rewards of from 5 to 10 per cent. of the purchase price of the block according to the degree of protection extended, and the most meritorious are awarded silver medals in addition.

The lessees are provided with printed permit forms. No cattle should be found within the block without a grazier in charge and the latter must be furnished with a form signed by the lessee covering the number of animals in his care.

The eventual aim is that the leases should be taken up by the village as a corporate body and managed by an elected council or *panchayat*. In this way the people will be invested with a measure of local self-government and become the protectors of their forests and their own interests therein. Without such co-operation protection would be hopeless.

The forests open to grazing under this system are not necessarily devoted to grazing alone. Many are being worked simultaneously for the provision of fuel and small timber on a rotation by small areas. Each annually worked area, or *coupe*, is closed for

a period of ten years, following the year of felling, to all grazing or extraction. Each *coupe* is surrounded by a fencing of dry thorns, which is constructed as the work of felling proceeds, so that the fence is complete by the time the produce has been removed. As a rule, it is these areas that the *kancha* lessees undertake to protect in addition to the block leased for pasture.

But little reflection will make it clear that the final word has not been said when we have reached the stage described hitherto. We have seen that intensive grazing and the existence of forest growth on the same area are incompatible. Excessive grazing means the more or less rapid extinction of the trees and shrubs, while the preservation and increase of woody growth entails the gradual diminution and disappearance of grass. It follows that the management detailed cannot go on in perpetuity and further steps must be taken if a permanent supply of fodder grass is desired. Such measures are actually contemplated. The plains forests of Nellore are being classified into fuel and fodder areas according to local demands, their actual condition, and the quality of the soil.

The management of the fuel areas will continue as laid down previously, but the fodder reserves are to be treated differently. Here annual *coupes* will be felled over, but the trees left as standards will be not more than 10 per acre and will be selected for the purpose of affording shelter for the cattle against sun and rain and regardless of their qualities as yielders of timber, fuel, or other produce, so that species generally considered as quite useless from a forest point of view—for example, *Dalbergia paniculata*—may well be selected so long as they have an ample crown. The fellings also will be so conducted as to discourage regrowth by coppice shoots.

Following on the felling, operations will be undertaken for the extraction of prickly pear and other thorny growth. In the following year the seeds of good fodder grasses will be sown in the areas thus freed of thorns. The *coupes* thus treated will be closed to grazing for a period of 2 or 3 years so as to establish thoroughly the new grass.

By these operations it is hoped to evolve pure grazing areas, studded with shelter trees, capable of supporting a much larger number of cattle than at present.

In this way it is expected to achieve the objects aimed at, that is to say, the reduction in the number of "drone" cattle by limiting the incidence of grazing and raising the fees so that the best cattle get the preference, and the provision of a sufficiency of fodder for the necessary cattle. Incidentally, it will secure to Government a financial return more in keeping with the benefits provided and lead to the improvement both of the pasturage and the yield in wood, all of which is in consonance with the motto of the Forest Department: *Meliora Speramus.*—[*Agricultural Journal of India*].

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THE ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

BY A. J. GIBSON, DEPUTY CONSERVATOR OF FORESTS, RESIN DIVISION, PUNJAB.

The Jallo factory, managed by the Punjab Forest Department, has been distilling resin of the *Pinus longifolia* since March 1915. Up to the 30th June last it had dealt with 72,000 maunds of resin, yielding 49,500 maunds of rosin and 125,000 gallons of turpentine.

Work, to start with, was largely experimental, as a process had to be devised which would increase the quantity of rosin and turpentine per crude maund of resin treated and which would obtain the very best possible qualities. In the forest year 1917-18, the factory distilled somewhat over 32,400 maunds of resin; from Punjab resin the yield in rosin was 72½ per cent. by weight of the crude resin and the yield in turpentine 2·07 gallons of oil to the maund of crude resin distilled.

As these yields on a commercial scale approximate the known theoretical yields, a short description of the plant and process can now safely be made public.

The plant employed is a complete unit of the steam distillation plant patented by Monsieur Ropars of Bordeaux, France, and cost, landed at site, roughly Rs. 30,000. The factory is situated on the North-Western Railway main line, 11 miles from Lahore and 22 miles from Amritsar, and the crude resin is railed from Rawalpindi, Jammu, Pathankote and elsewhere to the Jallo Railway station in wagon-loads, transit thence to and in the factory being by a tramway of 2 ft. gauge. This tramway has been most successful in reducing labour charges, handling over one lac of maunds of goods in the forest year 1917-18 at a working cost of a few rupees over Rs. 800.

The buildings and subsidiary plant employed have involved a capital expenditure of Rs. 1,09,000. As the *net* revenue earned by the concern has been Rs. 3,32,000, in round figures, up to date, the results can be called highly satisfactory, though it has to be remembered that the net revenue includes the royalty on the crude resin.

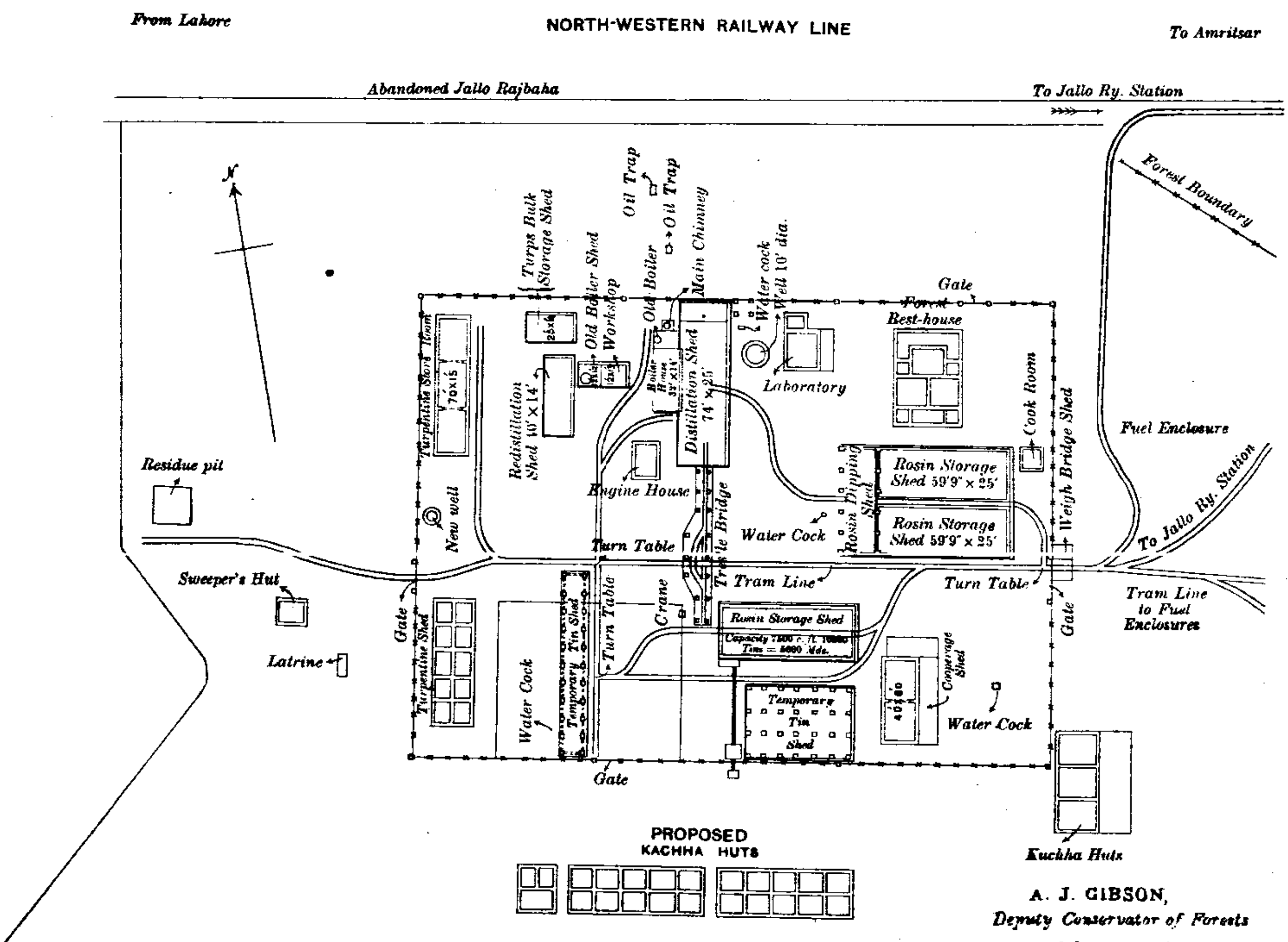
Plate 39 shows the general lay-out of the factory.

An easily grasped summary of the process is given in the chart below, the main fact to realize being that temperature is under perfect control at every stage of the process, which is so striking in actual demonstration that one visitor flippantly enquired if the still could play the piano.

Chart of the Jallo Oleo-resin Distillation process.

Crude resin melted, specific gravity adjusted by addition of turpentine, rested and filtered by gravity method. Then—

SITE PLAN OF GOVERNMENT ROSIN AND TURPENTINE FACTORY AT JALLO



A. J. GIBSON,
Deputy Conservator of Forests
9th August, 1918.

Fig. 1.

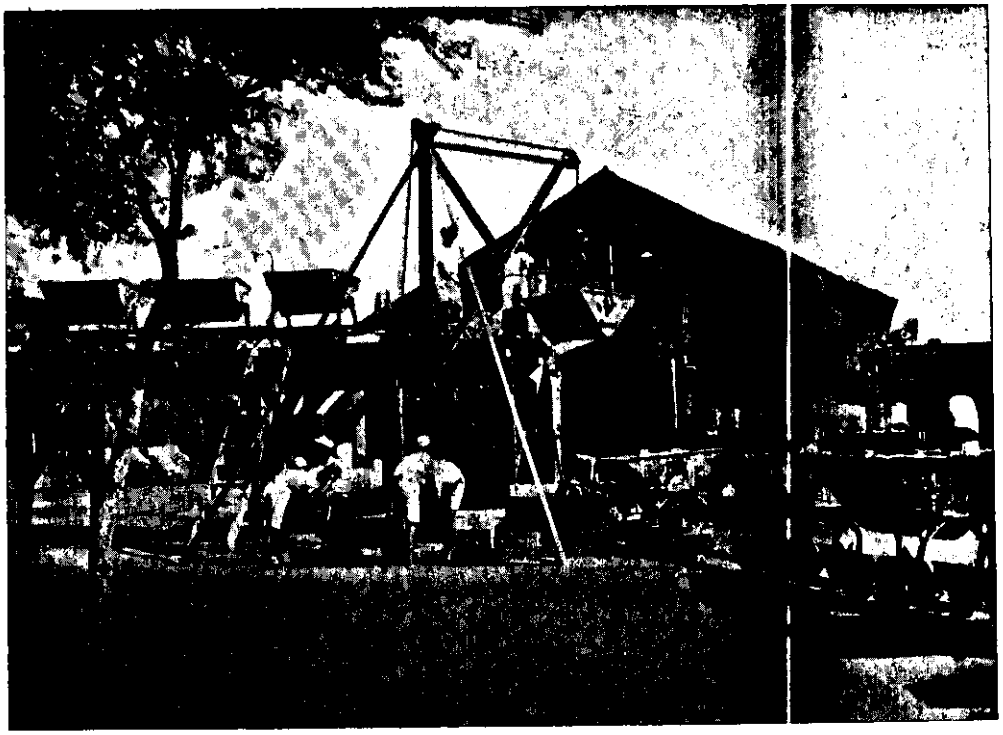


Fig. 2.

Photo.-Mechl. Dept., Thomason College, Roorkee.

ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

DISTILLED.

Rosin or Colophony (70 per cent. by weight of crude resin distilled). — Distillate.

Distillate: Bulk White Turpentine (1·7 gallons per maund of crude resin distilled). — Inferior Turpentine (0·3 gallons per maund of crude resin distilled).

Bulk White Turpentine: Re-distilled.

Quality I Turpentine (1·5 gallons). — Residue in still.

Residue in still + Inferior Turpentine: Re-distilled.

Quality II Turpentine (0·25 gallons). — Quality III Turpentine (0·15 gallons).

Loss in Re-distillation 0·10 gallons (under investigation).

The crude resin reaches the factory in soldered up 4-gallon kerosene tins, weighing on an average 20 seers (41 lbs.) net. As the resin gets very hard and solid in the cold weather, the tins, when necessary, are placed in batches of 200 in a steam-heated chamber where the temperature of 70° or 80°C. soon liquifies the resin sufficiently to enable the contents to come out easily. The tins are then removed, cut and opened neatly along three sides of the lid and emptied into a tipping wagon. Any resin adhering to the sides of the tins is washed off by means of steam jets. The tins are then taken outside the factory and are repaired and resoldered, to be sent back ultimately to the resin forest depôts in roped bundles of 32, weighing just over a maund. The cost of repairs and return journey averages three annas a tin. As new tins are at present hardly procurable at one rupee each, the economy resulting is self-evident.

The full tipping wagons are lifted on to a trestle bridge to be conveyed to the mixing vats. Plate 40, Fig. 1, shows the preceding processes photographically in some detail. The trestle bridge is necessary to get the resin to the correct height-level for the future stages of manufacture. The large 1,100 gallon mixing vats are

shown in Plate 40, Fig. 2, and Plate 41, Fig. 3, and their 120—100 maund charge of resin is tipped in in 1½ hours. The vats are fitted with helical mixers worked by hand-power, as seen in the above plates.

As the whole subsequent process of manipulation and distillation depends on the correct method employed in the mixing vats, some rather long quotations from the writer's report on "Modern Resin Factories as applied to India" are, perhaps, permissible: "In France it has been found that even the very best methods of filtration (whether cold hydraulic or hot ordinary) leave in the resin a fine almost impalpable dust, called 'poivre' = pepper, which causes even the best made colophony to be somewhat opaque. It was found, further, that heating the crude resin to between 50° and 80°C., the temperature varying with the quality of the resin being treated, and stirring slowly until the mass was completely melted and liquid, and then allowing the whole to rest, caused the contents of the mixing vat to separate into two distinct layers. The lighter resin with such impurities as chips of wood, bark, pine needles and so on would form the upper layer, while water, with the earth, pebbles and such like heavier impurities would form the lower layer. During the period of rest the fine 'pepper' or sand in suspension in the resin would by gravity sink to the bottom, leaving the resin as pure rosin dissolved in turpentine on the top, together with floating chips of wood, bark and needles, which are easily prevented from going over into the next stage in the process. Mixed with the water would be lumps of earthy resinous matter, 'scrape' and fluid heavy resin containing next to no turpentine; these would all find their way to the lowest part of the V forming the bottom of the vat. So much for the description of the functions of the mixing vat; the careful heating of the resin while slowly mixing; a period of rest; the separation of the mixture into two layers. But the last stage depends on the difference in specific gravity of water and of resin; these densities are very proximate, and when the two substances are moderately heated the water sometimes has a somewhat lower specific gravity and the difference in density is insufficient to cause a separation into two distinct layers. An extreme case is one where

Fig. 3.

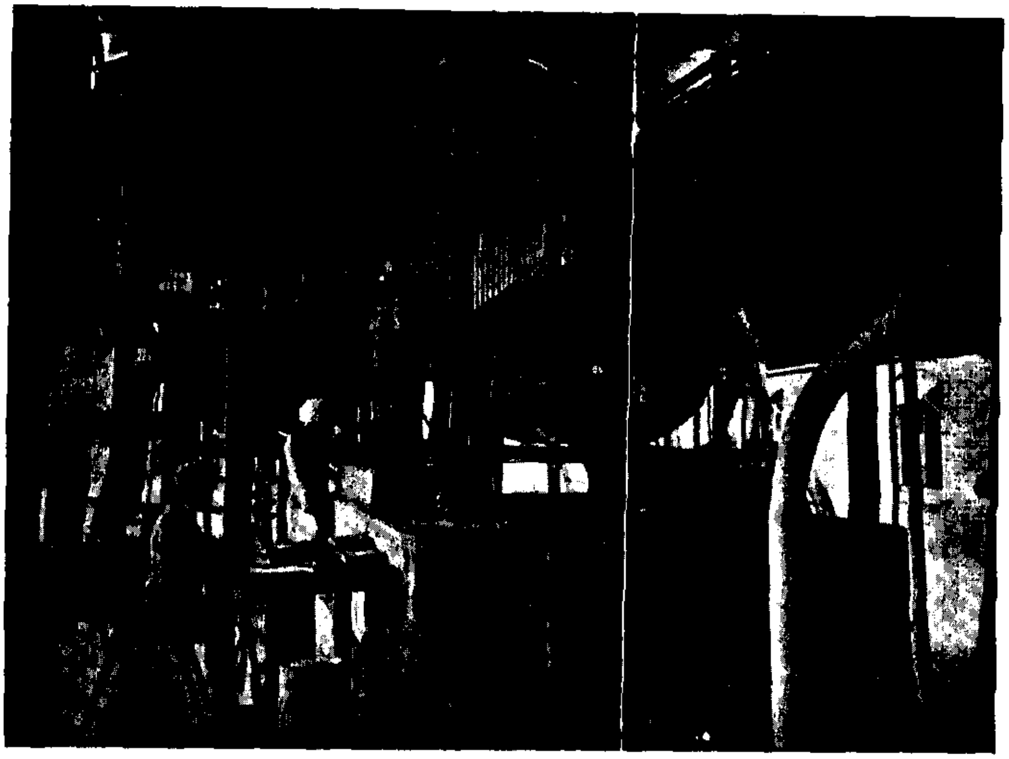


Fig. 4.

Photo.-Mechl. Dept., Thomason College, Roorkee.

ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

the resin contains much rosin and but little turpentine ; in such a case the water would float over the melted resin and the operation as described would be a hopeless failure. There are two ways of overcoming the difficulty :—

(*a*) By reducing the density of the resin by adding to it miscible liquids with much lower specific gravities, or (*b*) by increasing the density of the water by adding to it calculated quantities of soluble salts. For a fairly detailed description of the many methods, which have been tried and have failed in France, reference is invited to Monsieur Vêzes' book 'L'industrie resinière landaise sa technique actuelle, 1912.' It is sufficient to say here that for the former purpose, alcohol, petrol and white spirits among others have been used but with poor success, owing to the initial cost, and cost of the recovery processes ; in the end, most manufacturers adopted the method of adding turpentine from a previous distillation (generally 160 kgs. of oil to the contents of each mixing vat) and found the method most practical, especially when dealing with 'scrape' and heavy resins. For increasing the density of the water, cheap soluble salts such as sodium chloride, sodium sulphate and sodium carbonate are employed, but from a practical point of view their use is complicated by the danger of introducing into the plant active oxidizing agents, which would cause deterioration of the products. In the Punjab the addition of turpentine oil will first be tried, as this will involve very little additional expense and the plant and the products will be kept pure and clean ; for it has to be realized also, that though nothing is easier than to complicate the distillation by adding various ingredients, their total elimination (outside a chemical laboratory) is sometimes a matter of great difficulty, and the trade will not countenance adulteration, however innocent in its origin and this will be only more strongly the case when the Indian naval stores industry has to produce articles up to standard specifications and quality, as will undoubtedly have to be done if the industry is to be placed on a permanent sound commercial basis."

That was written in 1914. The addition of turpentine from a previous distillation has proved eminently satisfactory at Jallo

and the rosin has turned out to be of excellent purity, transparency and quality.

From the mixing vat the filtered resin goes to the storage tank, seen in the foreground in Plate 41, Fig. 3, and from that tank measured quantities go into the steam elevator, just showing in Plate 41, Fig. 3, and seen in more detail in Plate 41, Fig. 4. This last photograph also shows the still and the steam-jacketted rosin trough, mounted on wheels. The next photograph in Plate 42, Fig. 5, shows the still again, the great size of the dome and carry-over pipe to the catch-still (seen also in Plate 40, Fig. 2) being strikingly illustrated.

It was in perfecting the actual distillation process that most difficulties had to be overcome. In France a perfectly straightforward distillation, with a gradual increase of temperature being checked by an ever-increasing volume of injected steam into the still, works well. The inexperienced and generally untrustworthy Indian distiller, however, injected steam too violently and resin was carried over into the condenser worm (seen in Plate 42, Fig. 5). Consequently a catch-still was introduced. But the ordinary catch-still condensed all the best turpentine, contaminated with resin so to overcome this it had to be heated by an internal steam-coil. Then it worked satisfactorily. The turpentine from *Pinus longifolia* is a compound turpentine, the smaller half having a high-boiling point. Efforts had to be concentrated on getting the maximum quantity of oil to come over at the lowest possible temperature. This was achieved by fitting a large pressure-converter to the main steam pipe of the still, and reducing the boiler pressure of 112 lbs. to 72 lbs. in the still. The result was an increase of Quality I oil from 1·1 gallons per maund of crude resin to 1·5 gallons, which, on an output of 32,000 maunds per annum, represents an increased revenue of Rs. 16,000 a year. That small improvement pays the greater part of the B—Establishment charges of the year of the Resin Forest Division.

For the actual technique of this part of the operations another quotation from the writer's above-mentioned report is necessary:—

"The still in Ropar's plant—French = 'alambic'—is comparatively small with its maximum charge of 100 gallons of resin, that

Fig. 5.

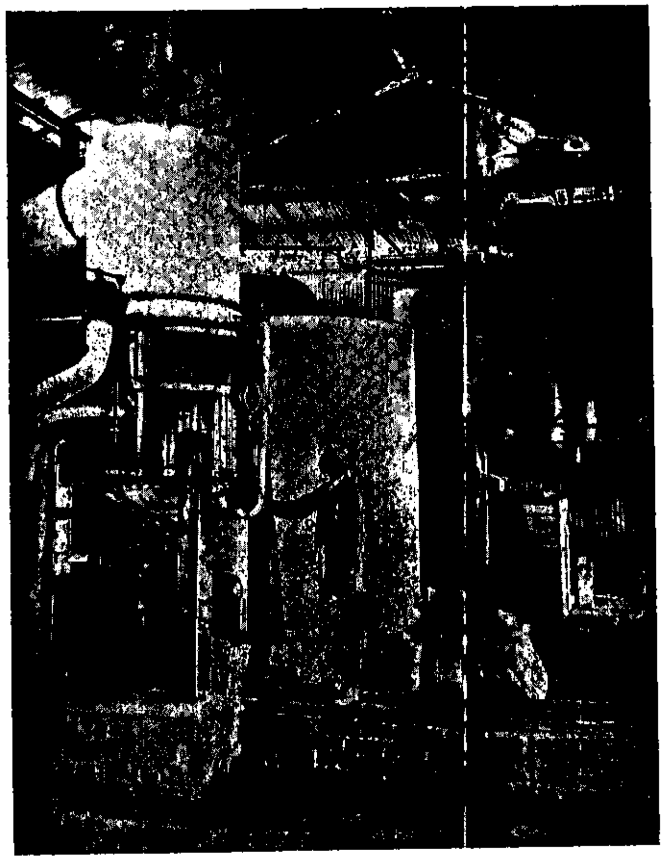


Fig. 6.

Photo.-Mechl. Dept., Thomason College, Roorkee.

ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

is, 11—12 maunds, considering the daily output it is designed to deal with. Its main features are its huge dome and large carry-over pipe to the condenser. The dome is fitted internally with baffle-plates and a sieve, both designed to prevent the mechanical carrying over of resin and rosin into the condensing plant. A small air-valve is also fitted in the dome and its operation will be described when the actual process comes under review. The still is steam-jacketted and fitted internally with a large number of mainly vertical steam pipes, connecting with the steam-jacket, thus ensuring the resin being broken up and coming into contact with a maximum heating surface, a very important point in designing a resin still, owing to the very poor heat-conductivity of the resin and rosin. The steam injector discharges into the still at the very bottom and was originally designed to force a jet of steam vertically down; however, this generally gave rise to great ebullition, so in the Punjab still the lower end of the injector tube has been fitted with a number of horizontally radiating hollow arms, closed at the ends, and pierced in one row of perforations along one side only, and always along the same side, so that when steam is injected a strong horizontal circular motion is given to the contents of the still, with the result that the level of the charge has no tendency to lift and danger from excessive ebullition is averted. The working of the still is quite simple. When the fresh charge of resin is let in, the resin is brought up to a temperature of between 110° to 120° by means of the steam-jacket and pipes. This occupies three or four minutes. A moderate jet of steam up to 8 kgs. per sq. c.m. (about 114 lbs. per sq. inch) pressure is then allowed to enter and the temperature gradually ascends to between 150° and 160°, and is kept from going further by gradually increasing the amount of injected steam, for as the distillation proceeds the available quantity of turpentine decreases and the separation of the rosin from the last part of the turpentine oil requires a considerable temperature. When the layer of oil in the distillate sample glass is only a few millimetres thick, steam injection is stopped and the last traces of oil and water are driven off by the heat of the steam-jacket and tubes, the steam here being at 112 lbs. pressure, enabling a high temperature to be obtained

The boiler is also worked at this pressure as a general rule. A steam-trap in the lowest part of the steam-jacket enables the condensed water in the jacket and pipes to be disposed of." The subsequent operations can again be best described by a reference to the report, slightly modified, here and there, to allow for changes in the last four years: "The turpentine vapour and steam leave the still *vià* the dome and the carry-over pipe and enter the condensing apparatus where they are condensed. This condensing apparatus is of a peculiar design, adopted, firstly because of the ease with which repairs can be carried out; secondly, because of the ability to create a small vacuum in the still by its use, and, thirdly, because of an automatic device by means of which air is largely excluded from the inside of the apparatus, whether it is in use or not. The last reason is the most important one, for it enables distillation to be carried out with air largely excluded, and it prevents internal oxidation of the copper worms while the plant is at rest, this being the most prolific source of the green colouration of Indian turpentine oil. The condensing tank or vat is circular and of large dimensions, and is designed to work with a consumption of about 2,000 gallons of cold water per hour, but by adopting a suggestion of the writer's, the hot water from the condenser in the Punjab plant is made use of to feed the boiler, thereby not only saving fuel, but reducing the total hourly water consumption from 2,300 gallons (requirements of boiler and condenser tank) to 2,000 gallons (requirements of condenser only).

"The actual condensing apparatus consists of two horizontal parallel iron annular pipes of large diameter, one at the top and one near the bottom of the condensing tank. Connected to these, at equal intervals, are eight vertical spiral copper worms of medium and equal diameter throughout their length, but considerably constricted where they join the lower annular pipe. Below the last named is another annular pipe parallel to it and about 3″–4″ away. This pipe has perforations along its upper side, and being connected to the cold water inlet pipe of the condensing tank the result of the design is to have a constant play of small jets of cold water on the lower surface of the condensing pipe just above.

This creates active local condensation, and its large diameter together with the constrictions in the lower ends of the worms tends to create a downward suction which imparts itself to the dome of the still, creating a small vacuum. The designed condensing surface of this apparatus is very large and the liquid products of a whole distillation can be accommodated if necessary without any overflow ; this ensures a thorough cooling off of the distillate before it reaches the separator, and thus a prolific source of loss of turpentine is avoided. The use of large diameter worms is not recommended because of the very indifferent results obtained by their use in practice when compared with tubular condensers. Any small diameter worm or pipes with well-proportioned strangulations designed to prevent too rapid a flow of the distillate are calculated to give good results, provided the *total* condensing surface is sufficient. As to the third reason advanced. The lower annular condensing pipe communicates with the separator for the discharge of the distillate by means of a goose-neck pipe, the levels being so arranged that a short column of liquid prevents the entry of air into the condensing apparatus, whether the still is working or at rest. In the morning, before starting the day's distillation, a small tap at the bottom of the goose-neck bend is opened and the worms are completely emptied. Possibly but not probably the liquid may be coloured green."

"This brief description of the condensing apparatus will, it is hoped, suffice to draw attention to its advantages. The writer, before placing the order for the Bordeaux plant, was greatly impressed by the theoretical advantages of tubular condensers as compared with ordinary worm condensers, but in practice they are most troublesome : they contain anything from 700 to 800 tubes and if a tube cracks or starts leaking and has to be replaced the labour involved is tedious and troublesome and quite beyond the capacity of the ordinary Indian 'mistri.' In the condensing apparatus adopted the break-down of a worm will cause but little difference to the working of the plant. It is disconnected from the flanges, and the liberated flanges are covered by simple circular plates and bolted on, the whole work not taking more than an hour

or so. The condensed distillate is collected in a separator—French 'bassin florentin.' (See Plate 42, Fig. 5.) In the separator the difference in the density of the turpentine and water is made use of to effect a very perfect separation, which enables the pure oil to be pumped direct from the separator to the bulk storage tanks, though a rest in an intermediate cistern for forty-eight hours is advisable. The action of the separator is simple. The water automatically discharges at a constant level through the goose-neck pipe provided, while the floating oil flows over from compartment to compartment in the separator (there are generally four divisions or compartments) depositing the flocculence it contains (French 'limon') till in the last compartment it is quite clear and limpid and fit for pumping to the bulk storage tanks.

"The rosin from the still is let out by means of a very large diameter valve situated below the still (see Plate 42, Fig. 5) and flows directly into the steam-jacketted colophony filter trough. (French ='waggonet') (see Plate 41, Fig. 4, and Plate 42, Fig. 6) where it passes through three super-imposed filter trays, the uppermost coarse and strong, as it has to bear the strain of the rapidly flowing rosin, the middle one of medium fineness and the lowest of very fine woven metallic cloth. The trough, as already mentioned, is mounted on wheels and can be wheeled away from the building along rails as soon as the still is empty. The troubles arising from the dense colophony fumes are thus obviated. The still being empty, the rosin valve is thoroughly cleaned by scouring it with a jet of steam conveniently placed for this very purpose (for otherwise the valve would stick at the next opening), and is closed again, the still then being ready for the next charge of resin. The air-valve on the dome of the still is for use during the drawing-off of the rosin. There being a slight vacuum in the still, the state of equilibrium produced might possibly prevent the outflow of the rosin, a condition of affairs which would be remedied at once by opening the air-valve. The device is a precautionary one, and in practice will not be used much, it is thought,..................." Nor has it been.

Fig. 7.

Fig. 8.

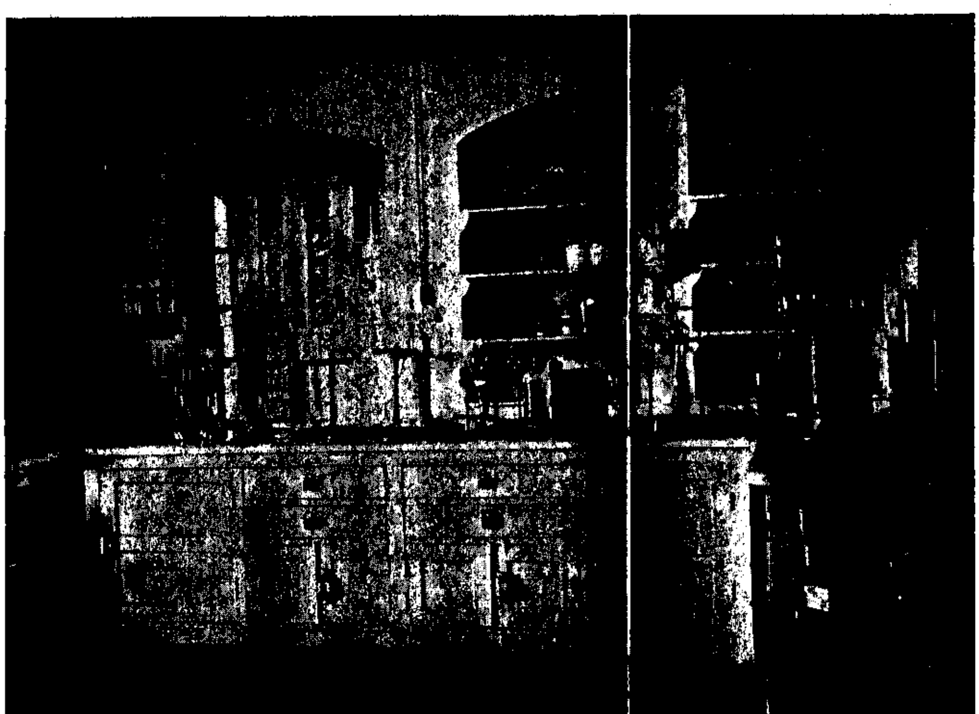


Photo.-Mechl. Dept., Thomason College, Roorkee.

ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

Fig. 9.

Fig. 10.

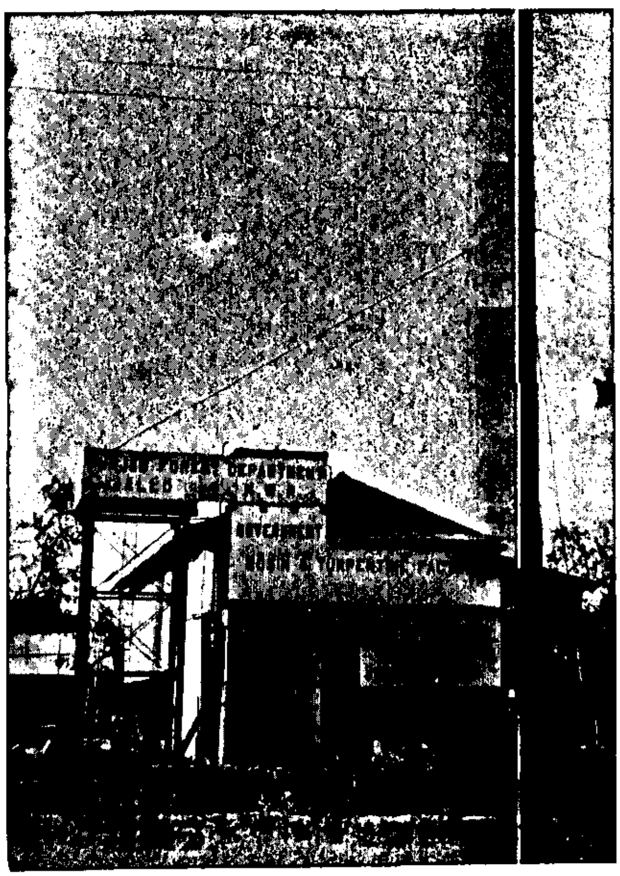


Photo.-Mechl. Dept., Thomason College, Roorkee.

ROSIN AND TURPENTINE FACTORY, JALLO, PUNJAB.

Plate 42, Fig. 6, shows the filtering of the rosin in the rosin shed and the filling of casks and bags with rosin, while the despatch of the manufactured goods forms the subject of Plate 43, Fig. 7.

Dealing with a new industry extreme care in control was necessary, so a well-equipped laboratory was included in the design of the factory, and the room shown in the Plate 43, Fig. 8, illustrates the site for the testing of turpentine, etc., and the elaboration of the methods now provisionally adopted as standard. It was found in practice that the best results were obtained by keeping the bulk white and inferior turpentines separate and redistilling these for Quality I and II turpentines (see chart given previously) separately as well. Even so, the cleansing of the condenser-coils presented great practical difficulties, and it was only by adopting a device of periodically injecting steam and hot water that the coils were eventually kept clean, and with clean coils that bug-bear of Indian turpentine-distillation – green oil—gradually disappeared and now offers no difficulty in its elimination.

Plate 44, Figs. 9 and 10, give views of the frontage of the factory, the latter with the sky-sign in position. The sign lit up electrically at night plus the characteristic odour of the neighbourhood, act as a permanent advertisement, for every traveller on the main line of the North-Western Railway is made aware of the industry either by means of eye or nose.

So much, briefly, for the history and development of the Jallo Rosin and Turpentine Factory in the Punjab. Imitation is the sincerest form of flattery and the United Provinces Forest Department is building a large factory at Bareilly on the Jallo model and system.

Some very clear-cut conclusions are deducible from this modern Punjab industrial experiment on a commercial scale.

The first appears to be that it pays to install the best and most modern apparatus available.

The second is, that as the Forest Department is a quasi-commercial department it has to be recognized that any new industry has more than a trace of speculation in it. Consequently, that the forest officer who drops may be a lac or so of Government

money in an unsuccessful venture is not necessarily to blame. More initiative in inaugurating new schemes would result if this were recognized more widely.

The third is, and it is put forward with poignant recollections of the writer's own experience in the matter, that money for financing new Forest Department ventures should be much more readily available and obtainable, than is generally the case. And, finally, a word of thanks is due to the Government who *believed* in little more than the bare word of a forest officer when he stated that Jallo would be a good venture and would yield good financial results on the invested capital, in spite of a mass of opinion and a record for the Resin Division from 1910 onwards which showed quite the contrary. It is, therefore, with a feeling of gratitude that one is able to record that the faith of the Punjab Government was not misplaced.

The work of the Forest Department in India and the work of its officers is gradually getting a little better known. But results in forest work are generally slow in showing themselves, and greater faith in the Forest Department and greater faith in the Forest Officers by those who rule their destinies is, perhaps, our greatest need at this time. For faith implies funds being made available and funds mean progress, while progress should be and is the keynote of Indian forest work.

NOTE ON OPERATIONS IN BAMBOO FLOWERED AREAS IN KATHA DIVISION.

BY H. R. BLANFORD, I.F.S.

INTRODUCTION.

The flowering of the more important bamboos in teak forest has an important bearing on the sylviculture of teak and comes so unexpectedly that some description of the success and failure of various works undertaken in Katha Division in 1906 and 1914—16 subsequent to general flowering of *Tinwa* (Cephalostachyum pergracile) may better prepare Forest Officers to meet the emergency of bamboo flowering.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Note on the operations in bamboo-flowered areas in Katha Division, Burma.

DISTRIBUTION AND HISTORY OF FLOWERING.

Tinwa (Cephalostachyum pergracile) may be considered to be the most important bamboo associated with teak in the Division.

Its presence is almost invariably indicative of a good class of teak and roughly 50 per cent. of the better class of teak forest may be said to have *Tinwa* associated with it. I may mention here that there is no *Kyathaung* (Bambusa polymorpha) in this part of Burma, the principal bamboos after *Tinwa* being *Wabo myetsangye* (Dendrocalamus Hamiltonii), *Wapyu* (Dendrocalamus membranaceus), *Thanawa* (Thyrsostachys Oliveri) and *Thaikwa* (Bambusa Tulda). *Tinwa* flowered in 1905-06 over the whole of the northern portion of the Division. It flowered in 1913-14 over the southern portion of the Division and except for isolated areas the whole of the *Tinwa* in the Division has now flowered.

THE 1905-06 FLOWERING.

Several experiments were carried out by Mr. McHarg. Unfortunately details of the work were not fully recorded. Areas were selected in the Mawhun, Nansiaung, Petsut and Tatwin Reserves and teak seed was dibbled in after the burning in the hot weather of 1906. Results were not very promising in the rains of 1906 and in 1907, nurseries were made and transplants put out during the rains. During the rains the teak seed dibbled in the previous year germinated freely together with a considerable amount of seed already in the ground. Weeding was done in 1906 and 1907 and in 1908, most of the areas were burnt and again weeded. As a result of burning, the growth of shoots from the stems which had been burnt back was greatly stimulated. Since then the areas have been cleaned from time to time. In many plots the results are good and the fine crop of young teak only needs occasional creeper-cutting and cleaning. The total area maintained (omitting some plots which were a complete failure) is 520 acres and the cost up to the age of ten years was about Rs. 10 per acre. The whole area of 520 acres is by no means fully stocked, but over a portion there is a very fair crop. In addition to the above, broadcast sowings were carried out in Mawhun Reserve but were not successful.

NATURAL REGENERATION.

It is, however, in its results on natural regeneration of teak that the flowering of 1906 is so remarkable. Practically throughout the teak forest in which *Tinwa* flowered the natural regeneration is most abundant and improvement fellings done in Mawhun, Nami, Nansiaung and Auktaw Reserves have revealed an extraordinary number of teak saplings, all of which date from 1906. That this is the case can be readily ascertained by counting the rings on stumps. These saplings appear to have held their own with the *Tinwa* for some ten years though they are now being gradually caught and suppressed by the more rapid growing bamboo, as is shown by the discovery of many dead or dying saplings completely grown over by the bamboos in Auktaw Reserve. Most of the forests were burnt over for one or two years after flowering to clear the dead bamboo and this seems to have stimulated regeneration. In the Auktaw Reserve where regeneration was most abundant, the area was burnt in 1906 and previously and protected in 1907. This appears to have given excellent results and in many places the growth resembles a good plantation. Heavy "Y" fellings are now being carried out over these areas as rapidly as possible.

The conclusions drawn from the results of 1905-06 flowering were as follows :—

1. That flowering of the bamboo results in a very plentiful growth of young teak. This arises partly from seedlings germinating after flowering and partly from advance growth already on the ground before flowering.

2. This young growth of teak can hold its own for a number of years against the young bamboo, but a large proportion is eventually overtaken and suppressed and should, therefore, require some assistance,

3. Artificial regeneration can be carried out successfully in the year of flowering at a low cost, but in view of the abundant regeneration of teak, work should be confined to areas where there are no seed-bearers but where the locality is suitable for teak.

THE FLOWERING OF 1913.

On my return from short leave in December 1913, I found that the *Tinwa* had flowered over the southern portion of the Division comprising the Pile, Pyinde, Nankan and part of Tatwin Reserves. Apart from a few minor experiments it is to be regretted that no extensive operations were undertaken early in 1914. The year of flowering and the two subsequent years are undoubtedly the most important in which to undertake any extensive operations to assist natural regeneration, as thereafter the young bamboo adds considerably to the difficulty and expense of tending the natural regeneration.

The Pile Reserve was selected as the most suitable area for concentrating work in connection with bamboo flowering. It is easily accessible and contains some of the best teak forest in the Division.

DESCRIPTION OF FORESTS.

The slopes are fairly steep in the western portion and it is on these that the best teak growth is found. The general character of the forest shows constant changes. In the lower ground near streams, *Wabo myetsangye* bamboo predominates with only an occasional teak and a few soft-wooded species such as Duabanga and Anthocephalus. Higher on the slopes the true teak forest is found with *Tinwa* and in places *Thanawa* (Thyrsostachys Oliveri). The principal associates with the teak are *Taukkyan* (Terminalia tomentosa), Garuga pinnata, *Tauksha* (Vitex spp.) and a few *pyinkado*, though this forest is about the northern limit of this species. Higher on the tops of the ridges the teak forest gives way to drier *Indaing* containing *In* and *Ingyin* with few bamboos.

In 1914. The work was chiefly confined to experiments in burning. Five plots of 10 acres each were selected in forest where the *Tinwa* was very thick and were treated as follows :—

1. All bamboo cut at the end of March and burnt on 17th April.
2. Burnt early (8th April).
3. Burnt 16th April.
4. Burnt late (30th April).
5. Protected.

Besides this No. 6, an area of 1 acre was clear cut and burnt. No very definite results were obtained on plots 2 to 5. *Tinwa* regeneration was nowhere abundant. In areas outside the plots where the forest had burnt early, bamboo regeneration was very plentiful. This was due no doubt to the burning taking place before the bamboo seed had fallen, thus providing a suitable germinating bed for the seed.

In areas protected for a number of years which were not burnt, the majority of the seed appears to have been unable to get through the layer of leaves to the soil and the regeneration was scanty. The results of the experiments on plots 2 to 4 were inconclusive largely owing to unsatisfactory burning as there was frequent rain during April.

Plots 1 and 6 burnt well and the resultant *Tinwa* regeneration was scanty. In plot 6 teak and *Yemane* (Gmelina) seeds were scattered broadcast and germinated well. The *Yemane* showed extraordinary growth and has since had to be cut back to assist the teak which is, however, doing well. In plot 1 a fair amount of natural teak regeneration has sprung up which is holding its own well with the help of occasional weeding.

The whole of the rest of the reserve was burnt over towards the end of April 1914, but owing to the damp season portions did not burn thoroughly. None of the dead standing bamboo burnt.

In 1914-15 and 1915-16 more extensive operations were undertaken and these are best dealt with under the heads of Natural and Artificial Regeneration.

A.—Natural Regeneration.

A seeding felling was carried out in 1914-15 over an area of 2,141 acres. Roughly about 60 per cent. of this might be classed as good teak forest. The operation consisted in opening out the cover over existing regeneration of teak and creating gaps and letting in light round seed-bearers to promote further regeneration. At the same time girdling of the teak was carried out and in some cases teak trees were girdled down to a minimum girth of 6 ft.,

where necessary, in the interests of natural regeneration. The area was burnt during the hot weather of 1915. It was weeded somewhat late in the rains of 1915. The results of the work on this area may be summarized as follows :—

1. Natural regeneration resulting from the bamboo flowering was found to be abundant. Wherever trees had been felled and burnt and the fire had been at all fierce, all teak seedlings were killed and no new ones had come up. This case was, however, somewhat exceptional and only where the débris from felling was very heavy. Where débris was lighter or where there had only been a leaf fire, the existing seedlings were sometimes burnt back, but in the majority of cases sent up fresh shoots. There was also considerable fresh regeneration. Where the area had escaped fire, the seedlings were growing fairly well but were in danger of being choked by weeds and the young *Tinwa*.

2. It was found that in many cases where large gaps had been opened out a very heavy growth of weeds, chiefly Strobilanthes and gingers, had sprung up and as the weeding had been delayed the greater portion of the natural regeneration was choked. In other cases, however, young *Tinwa* was predominant and here teak seedlings appeared to hold their own much better.

3. The most successful results appear, however, to have been obtained where a comparatively light clearing of the overhead cover had been made or where the patches round seed-bearers had been kept small. Here weeds were not nearly so vigorous or numerous and the seedlings seemed to have more chance of holding their own, although they did not show the vigorous growth of seedlings growing in the open. In view of the fact that considerable débris of bamboos still remained unburnt, it was thought better to fire-protect the area in 1916 in order not to risk losing much of the regeneration, which might be considered ample.

A number of sample plots were taken, some of which were burnt, and results show that if anything the regeneration has increased in the plots burnt but has remained more or less stationary in areas protected. It is probable, therefore, that burning or at any rate absence of protection would have done no harm.

The area was weeded during the rains of 1916. The cost of these operations for the area of 2,141 acres was :—

			Rs.
1. Seeding felling, 1914-15	...	...	2,088
2. Weeding, 1915 ...	...	...	368
3. " 1916 ...	...	...	395
4. " 1917 ...	...	...	389
	Total	...	3,240

The most important lesson that was learnt from the work was that if wide gaps are made in the overwood, early and repeated weeding is necessary.

In 1915-16 seeding felling was continued over an area of 1,600 acres. This area had been burnt over in 1914 and 1915; and when the work commenced, it was found that teak regeneration was not so plentiful as in the area which had been worked over in 1914-15, probably because most of the stock of teak seed in the ground germinated after burning in 1914 after a long period of protection, and as nothing was done to assist it most of it died. Judging from the results of countings on sample plots, however, the seeding felling has resulted in considerable increase of regeneration. The felling was made very much lighter and confined to small gaps round seed-bearers and over groups of regeneration.

Summary.—The results of this work throw some light on the difficult question of deciding on the best method of working in bamboo-flowered areas but still leave many matters for further experiment. I think the best way of summarizing these would be to describe the steps I should take and the experiments I should make if I had the good fortune to go through another flowering. As soon as the first signs of the flowering were evident, the first step would be to map out carefully the area and extent of flowering and select the most suitable areas for carrying out the work. I should then start in as early as possible with all available subordinates and labour I could collect to make a seeding felling. Over as large an area as possible, I should confine my efforts to clearing comparatively small gaps round seed-bearers, to

thinning out the overhead cover in teak forest and clearing over existing advance growth. I should, however, attempt a very heavy felling over a considerable area in order to compare the results. At the same time I should endeavour to alter the girdling coupes in order to carry out girdling over the area with the seeding felling where necessary.

As early and repeated weeding is absolutely necessary for the area on which heavy fellings are to take place, the area to be worked over in this way would largely depend on the subordinates and labour likely to be available during the early part of the rains. The whole of the area worked over in the first year would be burnt as thoroughly as possible. Weeding for two or probably two years would be necessary after the seeding felling. In the first year weeding twice would be necessary, the first to be done as yearly as possible in the rains. Any teak trees girdled in the seeding felling would have to be extracted in the fourth year, and on completion heavy "Y" Improvement fellings would be carried out followed by cleaning for as long as necessary. The work to be carried out on new areas in the years following the bamboo flowering would follow the same lines modified where necessary by experience. Until the seeding felling can be undertaken, if the area had not been previously fire-protected, I should burn as late as possible; but if the area had previously been fire-protected, I should continue to protect hoping in this way to retain in the soil the stock of teak seed (little of which would germinate if protected) until after the completion of seeding felling when steps could be taken to tend the resulting regeneration. If this area was burnt in the year of flowering, regeneration would result, much of which would die off, and be lost owing to want of tending. Protection of previously protected forest tends if anything to reduce the amount of *Tinwa* regeneration.

I do not think that it will pay to do much work to obtain further regeneration after the third year after the flowering, as by then the young bamboo will have got so far ahead as to render the work very laborious and expensive. As large areas as possible should be undertaken in the year of flowering and in the two or

possibly three subsequent years. Thereafter attention can best be directed to tending and carrying out improvement fellings in the areas worked over. The question of fire-protection after seeding felling is rather a difficult one. Judging from the results of protection after flowering in Auktaw the area should be protected after the first burning in the year of seeding felling. On the other hand, in Pile countings on sample plots would tend to show that continued burning serves to increase regeneration. It will probably be best to protect as soon as regeneration is considered sufficient, but it must be remembered that most of the dead bamboo escapes burning in the second year and does not finally fall over and die until the third or even fourth year. The question of continuing burning until the area is clear of this débris in order to facilitate work and inspection should be considered. The young teak would mostly be 2 or 3 years old and even if burnt back would send up fresh shoots.

B.—Artificial Regeneration.

An area of about 1 square mile was selected on fairly level ground suitable for teak but on which teak was generally somewhat deficient. Strips 1½ chains broad were laid out running north and south with two chains between each strip. Altogether the strips covered some 250 acres.

In 1915 it was only found possible to undertake a portion of this area. On 43 acres of these strips teak seed was dibbled, some clearing was done and the strips were then burnt. These dibblings failed entirely. It was impossible to trace any seedlings springing up from the dibbled seed. A part of this area was afterwards planted up in 1916.

On 49½ acres as much clearing was done as possible and the area was then burnt. Even then some of the dead bamboo had not fallen and remained unburnt.

These strips were planted up with teak with alternate lines of several different species planted 9′ × 6′. On the whole these did fairly well, though a certain number of strips had to be abandoned owing to their having been selected in unsuitable locality. The

main idea of the strip planting was to avoid pure teak and give a mixture. It was of course entirely unnecessary to introduce a further mixture of other species with teak in the strips, but the planting was largely experimental with a view to discovering suitable species to plant with teak. It is too early to give any definite opinion on this subject.

In 1916.-A further area of 66 acres of these strips were planted. The remaining area originally marked out in strips was found to contain too much teak forest to be worth while planting and was given up.

The most interesting point about the 1916 plantings was the success of teak and *Yemane* (Gmelina) planted with paddy and weeded by the villagers free. Not only was considerable expense saved but the growth was infinitely better; and after reaping the paddy, a fairly complete crop of teak 3 ft. or 4 ft. high was found free of weeds as compared with a height-growth of at most 18 inches and a very heavy growth of weeds that required repeated cutting back in the areas on which no paddy was sown.

The cost of the work carried out in 1916 was about Rs. 20 per acre including the first weeding in 1916. This is high. The cost of aligning and marking out the strips was about Rs. 3 per acre, but a considerable additional expense was due to the extra clearing of unburnt bamboo. The strips have not been a success. It would have been far better to have selected groups of heavy bamboo devoid of teak and to have introduced teak into these. One of the chief objections to the strips was that they often led either into poorer locality unsuitable for the best growth or into areas already stocked with teak. Natural regeneration of teak in teak-bearing forest is so plentiful after bamboo flowering and can be so easily assisted that artificial regeneration is often a waste of time and labour, which should be used to its utmost limit for 2 or 3 years after the flowering in assisting natural regeneration. In case it is found necessary or advisable to fill up gaps of non-teak bearing forest artificially, "taungya" plantations are undoubtedly the best and cheapest method. Even if it is impossible to obtain "taungya" cutters, it is well worth while felling departmentally and

allowing cultivators to sow a crop on condition that teak or other species planted are weeded. If this is done it may be found much better to wait for 2 or 3 years after flowering, as all the dead bamboo will then have fallen and will burn well. Whereas earlier the necessity of felling the dead bamboo will add very considerably to the expense.

Finally, I wish to state my opinion that bamboo flowering on a large scale and where the bamboo is an important species, should be held to be sufficient reason for revising all working-plans and girdling schemes in order to take full advantage of the flowering. Areas already being regenerated should continue to be tended, but new work should be confined to bamboo-flowered areas for 3 or 4 years at least, and efforts should be made during these years to cover more than the normal area. In other words, the system on which all our working-plans should be framed should be sufficiently elastic to allow for such phenomena as bamboo flowering.

SAL NURSERIES IN GORAKHPUR.

BY S. HOWARD, I.F.S.

As there are so few large Sal nurseries, the work done and the results obtained from the nurseries started in the Gorakhpur Division in 1917 may be of interest.

Small experimental nurseries had been made in this division by Mr. R. G. Marriott who found that nursery Sal could be put out into the forest by cutting down the stem to 2 inches length and the taproot to 18 inches or 24 inches. These "root and shoot cuttings" were planted out into prepared holes at the beginning of the rains and were tended during the rains.

The results were successful. That is to say, the vast majority of the plants are still alive after three years, and although the stems are still small (usually 12 inches to 2 feet high) they are healthy and will grow. Since they left the nursery these plants have never been watered artificially. During the rains, from June till October, the soil is worked round the roots and the grass cut just around

the plants. Except for this nothing is done and they find for themselves both in the cold and the hot weather.

The same method has been tried with plants dug up from fire-lines. It has failed.

Owing to the management of one of the Working Circles in Gorakhpur it is necessary to restock certain blanks artificially. With the present knowledge, sowings are said to be impracticable except under a combination of favourable circumstances which do not occur every year.

As a result of Mr. Marriott's experiments, two nurseries were started: one at Ramgarh, seven miles by pucca road from Gorakhpur, and therefore able to be visited regularly by the Divisional Forest Officer during the rains, and the other at Banki, some 20 odd miles away and at present unapproachable for the D. F. O. during the rains.

Mr. Marriott selected the sites for the nurseries, and when the present writer took over charge in November 1916, the Ramgarh nursery had been cleared of trees, stumps uprooted, land fenced and the soil dug to a depth of about 18 inches ; the Banki nursery was in the same condition by January 1917.

The area of *Ramgarh* nursery is 5½ acres. The ground was entirely cleared. A forest of Sal poles comes up to the nursery fence on three sides, but on the last there is a road bordered by a 'nilkanta' hedge some 3 feet 6 inches high, and beyond that open ground or land planted with quite young mango trees 4 feet to 5 feet high, some young teak, etc. *In other words not even side shelter is obtained from the east and even on the other three sides there is practically no side shade whatever.* The soil is a good loam or sandy loam. About a foot down it is even lighter and water drains down *through* the soil readily, but as the nursery is quite level it does not run off. It seems to be ideal for young Sal seed ings and this is greatly due to the way the water drains through the surface soil and while plenty of moisture is retained yet it does not stand and stagnate.

The area of *Banki* nursery is 3 acres. Before the land was cleared it was covered with miscellaneous jungle and not with Sal

as at Ramgarh. There is rather open forest only on the south side, and a little on the west. The nursery is slightly above the level of the surrounding country and was purposely so chosen to avoid flooding. The soil is not as good as at Ramgarh, the more elevated patches being much stiffer. Water does not sink through as readily causing more caking of the surface and, owing to the slight slope, it readily *runs off* which it does not do in Ramgarh. The soil on the south side of the nursery is lighter and better and the run off is less.

About the end of April the soil in both nurseries was well broken and finally dressed. Beds were then prepared by piling up the earth to form small paths 9 inches to 1 foot wide. The beds were ordered to be a definite size, actually they vary from about forty to fifty feet in length and 3½ to 5 feet in width. A cross section would be roughly as follows :—

These slightly sunk beds are not recommended everywhere. They happen to work here, however, judging by results.

The seed year of 1917 was a poor one in Gorakhpur but enough seed was obtained to stock the nurseries. Seed began to ripen by the end of May, and from then till about the 25th June they were collected daily and sown as soon after they were collected as possible and at any rate within 24 hours. Seeds were supposed to be sown in lines, the seeds to be 3 inches apart in the lines and the lines themselves 12 inches apart. Actually the seeds in the lines were sown so close as to be practically touching, though the lines were the correct distance apart.

As Sal seed has to be sown immediately it ripens and as rain does not usually fall till about June 15th, there is a hiatus of some ten days or a fortnight before the rain comes. The seeds need water to start germination properly and the newly germinated seedlings cannot stand lack of moisture. Artificial watering is, therefore, necessary till the rains set in and it is this which makes sowings in the forests impracticable.

The seeds were sown in shallow drills and the beds watered just before sowing. Watering was continued daily till the rains had fairly set in.

The percentage of germination is unknown but, for practical purposes, it was 100 per cent. The seedlings came up crowded together in the lines.

RAMGARH NURSERY.

By early in July the nursery was a mass of Sal seedlings with young grass and weeds between the lines and all over the paths. There was a certain percentage of failure in the earliest sown beds despite the watering but, except for these few, the lines were full of seedlings then about 2 inches high. A gang was put on at once to weed the beds and to work up the soil to a depth of several inches between the lines and as close to the seedlings as possible. The object of working the soil is partly to aerate the soil, but also to stop the surface becoming caked and water standing. By keeping the surface broken, the water soaks into the soil—a most important point. The whole nursery was cleaned of weeds within a fortnight, and it then became necessary to thin out the seedlings in the lines.

Once the nursery had been weeded the gang was dispensed with, but two malis were employed who, with occasional outside help, kept all the beds continually clear of all weeds and grass and the soil well worked.

The seedlings were thinned in the lines whenever the leaves began to interlace and the operation was continually repeated as the seedlings grew. This thinning out became practically mechanical, every alternate plant being removed. It was always done when the ground was well soaked so that a seedling could be pulled straight out without disturbing any of the others.

It was found that these seedlings, then three weeks to five weeks old, had a *perfectly straight taproot* some 9 inches to 12 inches long and a stem some 3 inches to 4 inches above ground.

In August it was noticed that the leading shoots were being bitten off. A miscellaneous assortment of insects were caught and sent to the Forest Zoologist. He concluded that the damage was

probably done by a grasshopper of the genus *Chrotogonus*. Before his answer came, the malis had recognized the grasshopper as one which does considerable damage to young wheat in November, so that as the same conclusion was independently arrived at it is probably correct. The grass was then scuffled off the paths in the hope of checking the attack but, although this lessened it, it did not prevent it and up to Christmas the leading shoots were repeatedly nipped off. The attack was very widespread, practically every plant being repeatedly nipped.

The behaviour of attacked seedlings varied. As far as could be observed none died. The smaller seedlings, as a rule, sent up a new shoot, or occasionally several shoots, from ground level, the original nipped shoot dying down entirely. These new shoots grew rapidly and soon caught up the other seedlings. The larger seedlings sent up a new shoot from the bud just below where they had been nipped. Occasionally, however, the smaller seedlings followed the rule of the larger or *vice versâ*.

By the middle of September, despite the attack on the leading shoots, the seedlings were 5 inches to 6 inches high with a few up to 9 inches, had several tiers of leaves, a *perfectly straight taproot* some 18 inches long and no large side roots, only small fibrous rootlets.

By early January 1918 despite the continuance of the nipping the whole nursery was full of fine healthy seedlings then seven month old and some 8 inches to 10 inches high and at distance of some 4 inches apart in the lines as a result of the continual thinning out by the malis. At this time the forest students under Mr. Wood dug up some seedlings. I understand that when they got down some 4½ feet they gave it up though the taproot had not ended. It was perfectly straight down. All this time the malis were still keeping the soil well worked and the beds weeded.

By the end of March 1918, the average height of the seedlings was about 10 inches to 1 foot with some up to 2 feet. The writer dug up one of average size and found the usual perfectly straight taproot with no side-roots to a depth of 3 feet. The taproot was still going down merrily and was at that point about as thick as a

boot-lace. It probably went on at least another 18 inches. The plants were quite healthy and had not shed any leaves. No water was given, artificially, since the first water in June 1917 and winter rains had failed. The plants were then from 8½ to 9 months old with good sturdy stems.

A frost occurred at the end of January severe enough to kill vigorous coppice shoots 3 feet high down to the ground in a neighbouring area. The seedlings were given no protection and were quite unaffected by it.

A few other observations are worth recording. The earliest sown beds were the only ones where failures occurred, and in those beds the plants were always the least vigorous. Except for these first few all other beds were perfectly successful, though up till about August or September the beds sown just at and after the break of the rains were the best. This latter difference had disappeared before Christmas and there was then nothing to choose except that the very earliest beds were distinctly poorer. Up to September the last sown beds had slightly smaller plants than those sown just about the break of the rains, but this was probably due to the fact that the first thinning and weeding reached those beds some days after the others and this early weeding and thinning out means a good deal.

By March the seedlings in the extreme west of the nursery were not as vigorous as the rest. Probably this was due to moisture from the surface soil being absorbed by the roots of the shrubs and trees just outside the fence.

Nilgai, cheetal and pig all got into the nursery, the two former over the fence (some 5 feet high) and the last through it. They did no great harm.

Various odd experiments were tried with the Sal pulled up in the early thinnings. The roots came up absolutely intact as far as could be seen. Some were immediately transplanted into other beds as they were (they were not out of the ground more than a minute), others were transplanted after cutting down the root and shoot. Neither did well but the latter were better than the former.

It is impossible to say how many plants originally germinated, but by the end of March it is estimated that there were some $2\frac{1}{2}$ lakhs of seedlings in the nursery.

All the above observations were made in person. The writer visited the nursery two or three times weekly from the end of June till the end of October.

BANKI NURSERY.

The writer did not see this nursery from germination till the latter half of October so that he cannot say what was done. It was supposed to be treated in the same way as the Ramgarh nursery. Although this nursery was successful, it was not nearly so successful as Ramgarh—at any rate up to the end of March 1918 when the writer last saw it. Germination was good. Very soon after germination it was reported that many of the seedlings were dying. This turned out to be due to a bad attack by cockchafer grubs. Luckily, it occurred early enough to re-sow the beds where plants were actually killed, but practically all the plants were attacked and the illustration (Plate 46) shows the roots of two typical seedlings from Banki nursery in March 1918 when the plants were $8\frac{1}{2}$ to 9 months old. It will be noticed they are very different from the long straight taproot described as typical of the Ramgarh seedlings.

No grasshopper attack was reported; but it had certainly occurred before October, though it was not as severe as at Ramgarh.

When the writer saw the nursery in October, the soil in some of the beds had not been worked for some time past; and, in most of the beds, only the surface was scratched and the plants had not been thinned sufficiently.

It appears probable that the weeding and thinning out was delayed and the soil not properly worked during the rains. This is borne out by the costs on this work as compared with Ramgarh.—Item 6 in the costs.

The site of the nursery is not as favourable as at Ramgarh. The water runs off the slope too much, and this was increased by the soil not being properly worked. The soil is not so good and the cockchafer attack was serious.

SAL NURSERIES IN GORAKHPUR.

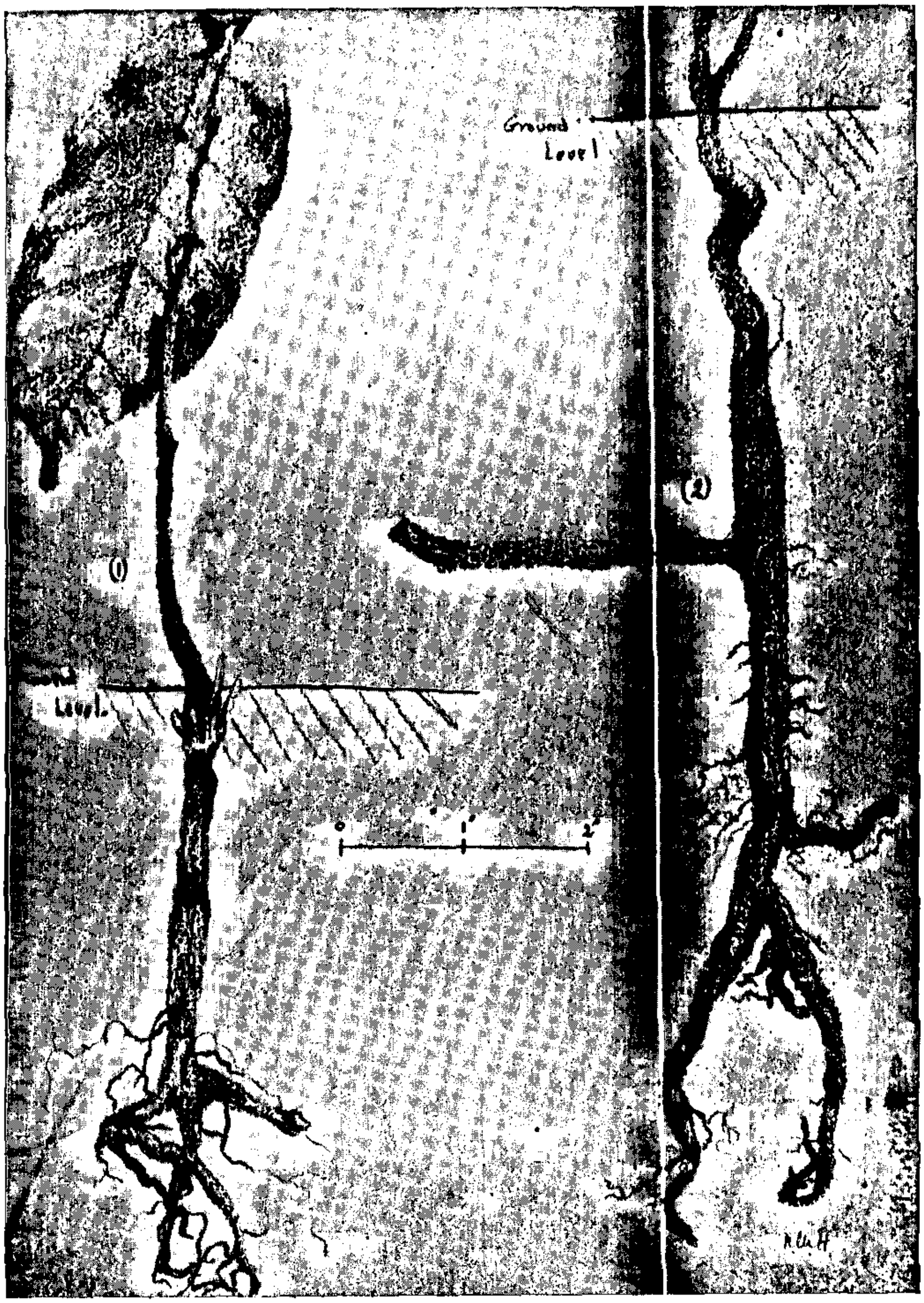


Photo.-Mechl. Dept., Thomason College, Roorkee.

Roots of two "Banki" Sal seedlings injured by cockchafers 8½ to 9 months old drawn to scale.
No. 1 only 5 inches. No. 2 only 9 inches.

The frost, which did not affect the Ramgarh seedlings, began to injure those at Banki. Grass strings were put up from end to end of the beds and a thin covering of grass placed across every evening at sunset and removed each morning. This prevented any further frost damage, but cost more than it should have done.

How far proper tending would have minimized the less favourable situation and the cockchafer attack it is not possible to say but the writer thinks it would have done a great deal.

By March the young seedlings had all shed their leaves and had begun to put out a fresh flush thus differing from Ramgarh. The seedlings were not watered despite appeals from the staff, and none had been hurt thereby when the writer left in April.

In March the nursery contained a certain number of blanks but there were a good crop of seedlings of an average height to about 8½ inches. The biggest plant measured was 19 inches high but all plants dug up had the same short, bitten off, twisted roots shown in the illustration.

Costs.

No.	Particulars.	Ramgarh 5½ acres.			Banki 3 acres.		
		Rs.	a.	p.	Rs.	a.	p.
1	Cost of making nursery, *i.e.*, felling trees, etc. In Banki the contractor was given the miscellaneous trees present as payment.	106	1	6	...	...	...
2	Cost of fencing excluding wire ...	68	10	0	35	12	6
3	Cost of digging, preparation of beds, etc....	56	14	0	34	0	0
4	Cost of collecting seed and sowing ...	30	1	6	31	1	0
5	Cost of watering	57	14	5	62	13	0
6	Cost of subsequent tending up to the end of October including the pay of the malis, etc.	92	1	10	29	14	4
	Total ...	411	11	3	193	8	10

The following points should be noticed in the costs. Wire is not included as it was in stock or obtained from other divisions. A cask of coal-tar used is not included for the same reason. The first three items will not have to be repeated to the same extent when fresh seeds are put in. Labour is rather more expensive at Banki than at Ramgarh; but, it must be remembered, a coolie in Ramgarh costs only about 2½ annas a day, so these costs are lower than they would be in many places. In Banki, they may go up to 3 and 4 annas in the rains.

The small amount spent under Item 6 at Banki should be noticed. It means only one mali was employed and therefore tending was neglected.

REMARKS.

(1) Sal seedlings cannot bear transplanting (except with a ball of earth when it is simple provided the taproot is not too long). No transplanting could have been more gentle than pulling up the plants in the thinning out when the ground was sopping wet and the plants less than a minute out of the ground. It was done as carefully as possible, and the roots were apparently undamaged though root-hairs must have been broken. Many of these died and those that survived only had two miserable little leaves months after. This does not apply to root and shoot cuttings but only to transplanting the whole plant.

(2) It was a mistake to make the lines of seedlings parallel to the short side of the beds. If they had been put lengthwise, it would have been easier to use hand cultivators if these prove practicable with young Sal.

(3) In Ramgarh, with a level nursery and provided the soil is kept worked, beds are probably unnecessary. The lines could run from end to end of the nursery and 12 miles apart is plenty of room to walk down. In Banki on the slope beds or contour ridges are necessary to help to prevent run-off.

(4) Early thinning out, if the seedlings are close, and continual weedings are important.

(5) Continual working of the soil is absolutely essential, partly to aerate the soil *but also to prevent the soil becoming caked and to allow the rain to soak into the soil at once.*

(6) With healthy seedlings no shade whatever is wanted. The fullest exposure to light both overhead and side light is beneficial. This remark does not apply to a *young* seedling which started life under cover.

(7) Full exposure is probably impossible in bad frost localities but a healthy seedling appears to be able to stand some frost without harm.

(8) A dry September, which is apparently advantageous in the forest with seedlings under shade, is harmful in the nursery.

(9) The cost of watering could be reduced by mechanical irrigation and a pump. It was all done by hand in Gorakhpur.

(10) There has been some discussion about the best age to take the root and shoot cuttings. Two year olds last year did as well as three year olds the year before as far as could be seen. It is probably the size that matters more than the age and, under proper nursery management, the seedlings are just as sturdy and 'carrotty' at one year old as they were at two years old from the former thickly sown nursery beds.

(11) The root and shoot cutting, though a solution to the problem of planting out the Sal, is not an ideal method. According to European ideas, planting of broad-leaved species is, in some cases, to be avoided and the Shisham in this country bears it out. Planted Shisham, as far as the writer has seen, are inclined to get stag-headed and to show hollowness at about 40 to 50 years of age. The Sal may very probably

be the same. Certainly the root and shoot cutting is a great shock to the plant. After three years the shoot is no longer than a good one year old tended seedling and nobody knows how many more years will be needed before vigorous growth starts, though it appears probable that those which have now been planted out for three years will go ahead this rains, *i.e.*, 1918. Experiments are badly needed on this question of artificial Sal regeneration, and it does not seem as if the solution were impossible.

CAUSE OF THE SPIKE DISEASE OF SANDAL (*SANTALUM ALBUM*).

BY C. E. C. FISCHER, I.F.S.

In an article under the above heading by Mr. R. S. Hole published in the issue of the *Indian Forester* for October 1917 it is stated that "*spike* is induced by unbalanced circulation of sap, which may be caused by a number of factors." Mr. Hole informs us that from his own observation the condition appears to have been brought about by four specified factors, *viz*., fire; death or damage to hosts; partial suppression by lantana or other growth; and exposure of trees hitherto growing under shade.

Further on he suggests four experiments by which "it is obvious that if the theory is correct, conclusive proof regarding it can now *easily and quickly* be obtained" (the italics are mine).

The theory propounded is ingenious, especially in the manner in which the results of Doctor Coleman's important experiments are made to fall into line. I venture to think, however, that the argument is not very convincing to those who have had much practical experience of spike in sandal, at least not at the present state of our knowledge.

In the issue of the *Indian Forester* for July of this year there is a contribution by Rai Sahib M. R. Ry. K. R. Venkataramana Ayyar which seems to me to answer, more or less completely, every

one of Mr. Hole's points and to show that, in the Javadis at all events, in no case has any one of the four factors brought about spike, and that, either by design or accident, each of the proposed experiments have been carried out without spike resulting. Mr. Hole himself has commented on Mr. Venkataramana Ayyar's paper in the same issue. Convenient as this practice may be, it is unfortunate, I think, that the comment should have appeared simultaneously, since this has probably weakened the force of an admirable exposition of the state of affairs in the Javadis, especially when the retort comes from one with the authority and in the position of Mr. Hole. This, however, by the way.

Mr. Hole defends his theory against the adverse evidence advanced by Mr. Venkataramana Ayyar by stating that he postulated that the conditions should be *prolonged.*

On a reference to page 431 of the October 1917 issue, I find the words "If this last condition is sufficiently prolonged"; this taken together with the words I italicised earlier, "easily and quickly" (page 438 of the October issue) hardly give that impression of duration now stipulated. In order that the theory may receive a satisfactory test, therefore, the word *prolonged* must be defined. In any case, of course, one experiment in one locality must not be held to be sufficient to be quite conclusive.

With this in view, I wish to record the following observations bearing on one of the four factors, made on Horsleykonda in the Chittoor District. Horsleykonda is a hill rising to 4,322 feet out the Madanapalle plateau in the Dekkan, bordering on Mysore territory. Sandal is not indigenous here but was introduced 40 or more years ago into a garden at an elevation of about 4,000 feet and has spread from it so freely that certain areas are now probably overstocked with that species. Unfortunately, lantana was also introduced by the misguided zeal of a missionary who built a bungalow hard by the garden referred to. Lantana is now very densely grown in places.

The records of fire-protection in the past are so unsatisfactory as to be of no practical value. For the past three years at least, however, it is known that that portion of the hill all around the

foci of the spread of sandal and lantana, some 800 to 1,000 acres, has been successfully protected from fire.

I first visited Horsleykonda on the 28th April last. About half way up I observed a sandal sapling, about 10 feet high, in the centre of the fire-line, on which the fire-tracing operations had left not a single green leaf. I have evidence that this sapling appeared quite normal and healthy before the burning. When I saw it first, the above-ground stem looked dead. I saw it again on the 16th May. Between the two dates there had been some heavy showers and I noticed that two green shoots had appeared on the main stem about 3 or 4 feet from the ground.

By the 1st June numerous shoots and leaves had appeared all over the stem and branches. Finally, I inspected this sapling on the 28th August and found that only the twigs had died and everywhere new leaves had come out. There was no sign of spike or any disease. The one peculiarity is that instead of forming a definite crown, the sapling has produced leafy shoots from about 2 feet from the ground. The wood is exposed in one or two patches on the stem below 1 foot.

There are a number of other sandal plants similarly burnt on the fire-line but this one is the most striking. I may mention two others of about 3 feet in height that appeared to be quite dead in April. Both now have a number of new and perfectly healthy and normal shoots springing from ground level. The old stem of one is quite dead; that of the other will die, I think, but has managed to produce half a dozen quite normal leaves.

Now all three specified plants are in the very centre of a 30 feet grassy fire-line and have, without the least doubt, been subjected to the treatment described for three years running if not more and yet they show no sign of permanent injury of the nature of spike.

The locality is one of comparatively light rainfall (about 30 inches) and the soil is distinctly poor.

It seems very doubtful, therefore, that injury by fire will lead to spike in sandal *in a locality where spike does not already exist on that species.* No doubt a plant weakened by fire would more

readily become infected, but that is a different matter from the fire injury being the direct cause of the pathologic condition known as spike.

So far very little has been done on Horsleykonda to eradicate lantana; but as operations are proposed and it is likely that fire will be called in to assist, this area may yet afford very valuable evidence.

That the infection of sandal with spike may be closely connected with lantana seems to me to be a quite tenable, though still unproved, theory as I shall try to show presently; even in the face of the fact that spike appears in sandal where there is no lantana.

I cannot conceive, were Mr. Hole's unbalanced sap theory correct, why spike should spread from a centre. Why should it not appear in different localities where the provoking factors are present, either simultaneously or at least withot geographical sequence?

That a condition of unbalanced sap circulation is set up in a spiked tree need not be disputed, but it seems more probable that this is the effect rather than the cause of the accumulation of starch.

The one theory that seems to fit in with the facts known at present is that spike is caused by bacterial agency, by what is known as *ultra-microscopic organisms.*

This is the theory that has been advanced as an explanation of the mosaic leaf-disease of tobacco, which in its mystery resembles spike, though it is far more easily communicated artificially. I am aware that there are those who refuse to accept this hypothesis, because, they argue, though the organisms may be individually invisible under the highest powers at present available they must be visible in the mass. Until our knowledge of microscopic organisms is far more perfect than at this date, the objection does not seem very valid; it would have been equally valid with regard to all bacteria and other minute bodies before Loewenhoek made the microscope available.

I venture to suggest, therefore, that the theory of an ultra-microscopic agency that either prevents the formation of the

necessary starch-converting enzyme or, at least, inhibits its action, is the cause of spike is a sound working hypothesis until it is definitely disproved.

This still leaves the difficulty regarding the spread of the disease. This necessitates the acceptance of a further supposition to explain why spike may appear at a distance and leave an uninfected area between. The one theory that appears to fit in with the facts reported hitherto is the dissemination by winged sucking insects. I do not pretend that the acceptance of this supposition solves every difficulty but no other agency covers so much ground or leaves so little unexplained. It seems to me at least possible that for infection without contact (and Dr. Coleman has demonstrated the feasibility of infection by contact) the virus, whatever it is, *must* pass through the body of some intermediary host, a sucking insect, just as the malarial parasite passing from man to man must pass through the body anopheline.

That there is some connection between spike and sucking insects is no new conception. As far as I know, it was first advanced by Mr. T. N. Hearsey, Extra-Assistant Conservator of Forests, who, to my personal knowledge, held this view at least as far back as 1904, basing it on observations made by him in Coorg; though at that time he believed that spike was directly caused by the insect.

If the possibility of the transference by insects is admitted, it can also be admitted as possible that the disease exists in lantana, though it may not produce the same morphological symptoms, and that it was originally communicated to sandal *viâ* insects from lantana. Once infected into sandal, the spread might then go on from sandal to sandal. But this admission would only carry us one step back since the particular lantana in question (*Lantana Camara*, Linn.) is an introduced species, and it is improbable that the disease was introduced with the lantana from America. It is known, moreover, that a condition similar to spike in sandal is present in a number of indigenous plants of very varying affinity, habits and habitats, and that the individuals of some of these plants in this condition are probably far more numerous than

spiked sandals and certainly more widespread. It may be that sandal first caught the infection from lantana, but unless it can be proved that the infection can come from lantana only, the question is not of very great practical importance.

I do not wish to deprecate experiments on the lines suggested by Mr. Hole. Even if only negative results are obtained from them, they will be of value nevertheless. But I desire to point out the danger of obscuring the direction which, to many of us, the results of Dr. Coleman's experiments seem to indicate in no unhesitating manner as the line of further action and one likely to lead to a more fruitful harvest. It is, of course, not within the power of most Forest Officers to help on Dr. Coleman's experiments directly, but that is precisely where the danger lies. It is easy for them to work on the lines proposed by Mr. Hole, and this may lead to neglect of observation and record of observation in the other direction, and at this stage an apparently almost insignificant tem of evidence may lead to very important conclusions.

Mr. Hearsey has been on special duty for some time on the study of insects in connection with sandal and has already obtained some very interesting information. We may hope that if Dr. Coleman's work and Mr. Hearsey's are pushed on concurrently, some very important results will be available before long.

A NEW SPECIES OF *HOPEA.*

BY R. S. HOLE, FOREST BOTANIST.

Hopea canarensis, Hole, sp. n.: species allied to *H. racophlœa,* Dyer, and *H. glabra,* W. and A. From the former it differs in the more nu merous lateral nerves, the rounded or cordate base of the leaves, the eciliate calyx lobes with the outer two larger and different in shape and the ovoid or oblong stylopodium ; from the latter it differs in the larger leaves, glandular nerve axils, longer petioles and broader fruit wings.

Species *H. racophlœae,* Dyer, et *H. glabræ,* W. and A. affinis ; ab illa differt nervis lateralibus numerosioribus, basi foliorum rotundata vel cordata, stylopodio ovoideo vel oblongo, laciniis

calycis eciliatis duabus exterioribus distinguendis dimensionibus majoribus figuraque; ab hac foliis majoribus, axillis nervorum, lateralium glandulosis, petiolis longioribus et alis fructus latioribus differt.

In 1913, Mr. F. A. Lodge, C.I.E., Conservator of Forests, sent fruiting specimens of a *Hopea* to Dehra Dun for identification which could not be matched there with descriptions or specimens. Specimens were accordingly sent to Kew but they could not be matched there. Mr. C. D. McCarthy, Conservator of Forests, subsequently sent to Dehra Dun flowering specimens of the same tree in 1917 which have now made it possible to define and publish the species. A full description and illustration of it will shortly be published in the Indian Forest Records. The species is as yet only known to occur in the hill forests of S. Canara and is reported to be a large tree producing clean boles 6 to 8 feet in girth and 50 to 60 feet long. Its timber is as yet practically unknown but is likely to be valuable judging from that of its nearest allies. The writer desires to tender his warm thanks to Mr. Lodge and Mr. McCarthy for the specimens and information regarding this tree which they have sent to Dehra Dun and to Sir David Prain for kindly having our specimens compared with the material at Kew.

EXTRACTS.

POETRY.

WEST AWAY.

(Home Thoughts from the Jungle.)

April in the Jungle: hot weather comes a-wooing
(Dry and dead and leaves upon the ground).
Time to quit the station and be up the hills and doing
(Pack the tents and start upon the round).
All the night we'll hear
The little jungle deer
Crying till the coming of the sun;
Where the future's like the past
And the next is like the last,—
But the Jungle is His Majesty's, and service must be done.
West away! West away! Heart and longing cry,
Where the guns of battle roar, where the bullets fly;
"'Also serve who stand and wait'?" Very likely true
But we who do the waiting—oh! wouldn't we be you.

May Day in the Jungle: just a little hotter
(*And* the days of May are thirty-one).
Still the weary wandering, the plodding and the potter
(Kill the time with dog and rod and gun).
Now across the night
The lightning blazes bright
Crash of thunder, rattle of the showers;

And we eat and work and sleep
While the lagging watches creep,—
For the Jungle is His Majesty's, and therefore it is ours.
West away! West away! What's the news to-day?
Paper's just a fortnight old, but what's it got to say?
"Look at what you're missing now." Well we've got to miss.
That's for *you*, so bless your luck; *we* go on at this.

July in the Jungle: the south-west rains are breaking
(Flood and torrent tearing tree and stone).
Time for men who live in tents homeward to be making
(Just a hundred days of it—alone).
Weary weeks to come
When the rain will beat and drum,
Roofs will leak and fevers fill the air;
But unless the luck goes wrong
Some one else may come along,—
And the Jungle is His Majesty's, and some one must be there.
West away! West away! You who've lived and fought
What of those who're out of it? Can you spare a thought?
"Some one's got to do your job. Funk it?" God forbid.
We will do it, do it, do it; but—remember that we did.

[B. in the *Spectator*.]

FOREST INSECT CONDITIONS IN INDIA.

BY C. F. C. BEESON, M. A., FOREST ZOOLOGIST, FOREST RESEARCH INSTITUTE, DEHRA DUN.

Since the establishment of forest research on organized lines in 1906, the work of the branch of Forest Zoology has been confined to the collection of information on the life-histories and economics of the insect pests of a few of the more valuable timber trees, and so far little attention has been paid to the question of

control measures. The need for the early introduction of systematic methods for the control of the more important species has been recognized, but in Indian forests the necessity is far less urgent than that existing in other countries where systematic forestry is practised.

The insect pests of forests may be roughly grouped under three heads :—

(1) Insects which kill trees.
(2) Insects which cause loss of increment without causing death.
(3) Insects which cause technical damage to timber and forest products.

Insects of group (3), technically injurious species, are to be found wherever tree growth exists, but insects of groups (1) and (2), physiologically injurious species, are distributed with less uniformity throughout the forest tracts of the world.

The object of this paper is to attempt a comparison of the primary pests of Indian forests, *i.e.*, defoliators, bark-beetles, and heart-wood borers, with the known primary pests of other countries, but as a result of lack of data one is restricted to a consideration of forest insect conditions in the temperate regions of Europe and North America.

I. CENTRAL EUROPE.

The early development of systematic methods of forest management in the countries of Central Europe and in particular in Germany established at an early date rational lines of study of forest insects as a branch of applied entomology. Forest entomology may be said to have been created in Germany a century ago by Ratzburg and his co-workers Hartig and Nördlinger.

The insect pests of European forest trees have thus been under observation sufficiently long to furnish definite conclusions as to the types of insect damage that are normal in virgin forests on the one hand, and in forests under systematic management on the other.

The principal primary pests of Central Europe are mainly pests of coniferous forests. As is to be expected, evergreen conifers suffer far more from insect injury and especially defoliation, than do hardwoods which renew their foliage yearly and exhibit in general far greater recuperative powers.

The Nun Moth, *Liparis (Lymantria) monacha*, L., fam. Liparidæ, is a polyphagous defoliator of conifers and hardwoods. Nun Moth epidemics last generally for 5—7 years and are accompanied by the total destruction of spruce and pine forests over wide areas. The more important epidemics of the last century occurred in 1835—40 in North Germany, in 1845—67 in Prussia and West Russia, in 1889—92 in South Germany, in 1898—1901 in Sweden and Germany, and in 1905—11 in Austria, Saxony, and Prussia.

Dendrolimus pini, L., fam., Lasiocampidæ, is the most important primary enemy of the pine (*Pinus sylvestris*); in an outbreak, which lasted from 1862—72, some 4,000 square miles in Russia and North Germany were affected.

The Pine Looper, *Bupalus pinaria*, L., fam. Geometridæ, and the Pine Beauty, *Panolis griseovariegata*, Goetze., fam. Noctuidæ, are other dangerous defoliators of pine woods. The last looper epidemic in 1892—96 resulted in the clear felling of over 150 square miles of pine forest in Bavaria.

Fatal defoliation of beech and oak and other hardwood forests is due to outbreaks of the Gypsy Moth, *Porthetria dispar*, L., the Gold-tail and Brown-tail Moths, *Euproctis (Actornis) Chrysorrhœa*, L., and *Nygmia phœorrhœa*, Don., fam. Liparidæ.

Borers.—Of bark-beetles the most important primary pest of coniferous forests is *Ips typographus*, L., fam. Scolytidæ; *e.g.*, in 1781—83 this species killed off 2½ million spruce in the Harz mountains. Severe epidemics occurred in 1862 in East Prussia and in 1868—70 in Bohemia; in the latter outbreak 400 square miles of pine forests were devastated. In 1902 some 150,000 spruce and silver fir were killed off in the Vosges mountains.

In Europe where natural regeneration of the forest is permitted only in accordance with sylvicultural rules, or else regeneration is entirely artificial, one finds that young growth is subject to the

attack of primary insects. Sowings, plantations and natural regeneration areas of spruce, pine, and fir are fatally injured by weevils, *e.g.*, *Hylobius abietis*, L., and *Hylobius* spp., fam. Curculionidæ; conifers and hardwoods by cockchafer grubs and beetles, *e.g.*, *Melolontha vulgaris*, L., and *M. hippocastani*, F., fam. Scarabæidæ.

UNITED STATES OF AMERICA.

Although forest entomology is at present the least developed branch of applied entomology in the United States, yet it has shown that the very serious losses which North American forests suffer from the depredations of primary pests are controllable by simple non-expensive methods. The average annual loss due to insect damage is estimated at over £12,000,000 which is upwards of £2,500,000 annually in excess of the average yearly loss due to fires.

Defoliators.—The primary pests do not include many species of defoliators. The most injurious appears to be the Large Larch Sawfly, *Nematus erichsonii*, Hartig, fam. Tenthredinidæ, which during several extensive outbreaks since 1880, has killed off from 50 to 100 per cent. of the mature larch over vast areas in the North-eastern United States.

The defoliator of greatest local importance is the Gypsy Moth, which, introduced from Europe to the States in 1868, is now widely spread throughout eastern New England, defoliating forest, shade, and fruit trees, and agricultural crops, and entailing enormous losses and the expenditure of millions of dollars in control work. In recent years it has become established in forest areas, defoliating especially oaks, aspen, poplar, beech, limes, birch, and pines.

Bark-beetles.—North American coniferous forests suffer from extensive invasions of various species of bark-beetles of the genus *Dendroctonus*, fam. Scolytidæ.

In 1890—92 the Southern Pine Beetle, *Dendroctonus frontalis*, Zimm., killed off a large proportion of spruce and pine over 75,000 square miles in West Virginia, Maryland, and Columbia. The Eastern Spruce Beetle, *D. piceaperda*, Hopk., killed off mature

spruce over thousands of square miles in the forests of North-eastern Maine.

The Black Hills Beetle, *D. ponderosæ*, Hopk., has killed off in a ten year period about a hundred million cubic feet of western pine in the Black Hills National Forest of South Dakota. The sugar pine, silver pine, western yellow pine, and lodge pole pine of the region north of Colorado and Utah, are attacked by the Mountain Pine Beetle, *D. monticola*, Hopk., and the Western Pine Beetle, *D. brevicomis*, Lec., and in direct consequence millions of feet of timber have died. In one locality in Oregon 90—95 per cent. of the lodge pole pine on an area of 150 square miles was killed off in three years. The Douglas fir throughout the region of the Rocky Mountains suffer very severely from the ravages of the Douglas Fir Beetle, *D. pseudotsugæ*, Hopk.

The Hickory Bark-beetle, *Scolytus quadrispinosus*, Say., has caused the destruction of an enormous amount of hickory timber throughout the Northern and Eastern States.

The hardwoods, *e.g.*, oaks, chestnut, beech, elm, etc., suffer far less from the work of primary pests, but are subject to the attacks of secondary heart-wood borers such as the timber worms, *Eupsalis minuta*, Dru., and *Lymexylon sericeum*, Harr., the carpenter worms of the genus *Prionoxystus*, and ambrosia beetles, shothole borers, and turpentine borers.

CANADA.

The forests of Canada, covering an area of one and one quarter million square miles of which about 400,000 square miles contain merchantable timber, are composed chiefly of conifers. Outbreaks of primarily injurious insects occur in virgin forest on a large scale, and the need for investigation was recognized by the appointment of a forest entomologist in 1911.

Defoliators.—Of the defoliators the most important pests are the Large Larch Sawfly, *Nematus erichsonii*, Hartig, fam. Tenthredinidæ, the Spruce Bud Worm, *Tortrix fumiferana*, Clem., fam. Tortricidæ, the Brown-tail Moth, and the Pine Butterfly, *Neophasia menapia*, Felder.

The Large Larch Sawfly during the last 20 or 30 years has shown itself to be a serious pest of the larch (*Larix americana* and *Larix* spp.). In 1881—86 it killed off by repeated defoliation practically all the mature larch in Eastern Canada: outbreaks occurred again in 1894—98 and 1903—06. Considerable damage has been inflicted by the Spruce Bud Worm to the balsam and the spruce, especially in the eastern regions of Canada, and to the Douglas fir *(Pseudotsuga douglasii)* in Vancouver Island.

Canadian forests of both coniferous and broad-leafed species (oak, elm, and maple) are threatened also by the Brown-tail Moth, which appeared 12 or 15 years ago and is now endemic in the transition zone of Nova Scotia, and epidemic in the boreal parts of New Brunswick. There is every possibility, if the insect becomes established, of its being a serious pest throughout the transition zone of the Dominion.

Borers.—The destruction caused by defoliators is slight compared with that due to the depredations of bark-beetles of the genus *Dendroctonus*. What has been said about these species in the Rocky Mountains and the Pacific Coast region of the United States holds for corresponding regions in Canada. The tree species suffering most seriously are *Pinus ponderosa*, *P. monticola*, *P. murrayana*, *Pseudotsuga mucronata*, and *Picea sitkensis.*

It must, however, be noted that the three most injurious defoliators of North America and Canada are not indigenous species but introductions from Europe.

II. British India.

There are 250,000 square miles of forest in India and Burma of which 108,000 square miles are under more or less systematic management, but in at least half of this area we have little idea of the rôle played by insect pests or even if economically important pests exist. Although some 55,000 square miles of forests are managed under Working Plans at the present time, we have not as yet brought into force methods to ensure the systematic record of damage due to insect pests, nor are we able to calculate the value of the annual loss due to any one species. The data available

however, show, even in a rough comparison, that well-marked differences occur between forest insect conditions in India and those in other parts of the world.

Defoliators.—Of defoliators in coniferous forests India appears to have no species that correspond to the sawfly and lasiocampid caterpillars of North America and Europe. The Himalayan pines, silver firs, spruce and deodar, and the evergreen oaks of the mountain forests are (so far as any records are available) entirely free from primary defoliation with fatal results.

Of the hardwoods several species of lepidopterous defoliators are known and widespread. In deciduous forests the teak, *Tectona grandis*, is defoliated periodically, and frequently annually, throughout the whole of its distribution by two species, *Hyblæa puera*, Wlk., fam. Noctuidæ, and *Pyrausta machæralis*., Cram., fam. Pyralidæ, and several species of Arctiidæ, but no case of fatal defoliation sufficiently extensive or prolonged has been recorded which would cause these species to be considered as primarily injurious insects. Complete defoliation of teak is followed by a rapid renewal of the crown foliage or by temporary production of epicormic shoots. The injury is thus restricted to loss of increment and occasional stagnation.

The Sal, *Shorea robusta*, is defoliated by numerous species of Lepidoptera, most of which appear in groups or associations, *e.g.*, *Dasychira thwaitesi*, *D. horsfieldi*, *D. mendosa*, *Lymantria ampla*, *L. bivittata*, *L. semicincta*, which defoliate hundreds of square miles of Sal forest in the eastern parts of its range. The earliest record refers to an attack in 1884 in which 200 square miles of forest north of the Brahmaputra river were completely defoliated. *Trabala vishnu*, Lef., *Suana concolor*, Wlk., fam. Lasiocampidæ, *Ingura subapicalis*, Wlk., fam. Noctuidæ, and other species periodically defoliate the tree in the Central Provinces and in the United Provinces.

Almost every timber species of importance in the deciduous and evergreen forests supports a series of lepidopterous and coleopterous defoliators and pruners, nevertheless in the above-quoted instances, and in the arid country and littoral forests where pests

have been less extensively studied, there is a complete absence of epidemics which have resulted fatally to the forest as a whole or to all the individuals of one tree species in the forest.

Borers.—The Himalayan conifers are attacked by species of bark-beetles generically allied to those of the European and American conifers, *viz*, *Ips*, *Polygraphus*, *Cryphalus*, *Scolytus*. *Ips longifolia*, Steb., is the most destructive pine bark-beetle throughout the zone of *Pinus longifolia* and *Pinus excelsa*. The deodar (*Cedrus deodara*) is attacked by species of *Scolytus*, a genus which is confined to broad-leafed trees in European and American forests. Under normal conditions the bark-beetles are not primary pests, but a few instances occur in which appreciably large areas of forest have been devastated by epidemic outbreaks, *e.g.*, in 1903—06 in the forests of *Pinus Gerardiana* in Baluchistan by *Polygraphus trenchi*, Steb; in 1908—10 in deodar forests in the Simla Catchment Area by *Scolytus major*, Steb.; and in *Pinus longifolia* forests in the United Provinces in regeneration areas and following on serious fires by *Ips longifolia*, Steb. The case of primary outbreaks of *Ips longifolia* in regeneration areas of chir pine is a habit of recent development and hardly to be considered as normal, as it is associated with the changes in forest management which favour the concentration of regeneration operations and consequently of breeding grounds for the insect. Other apparently primary activities of the Pine Bark Beetle in plantations have recently been shown to be consequent on previous attack by bark blister fungi. Bark-beetles of timber species in deciduous and evergreen forests are, in all observed cases, undoubtedly of secondary origin. The species of *Sphærotrypes* and other bark-beetles which breed in *Anogeissus latifolia*, *Terminalia tomentosa*, *Shorea robusta*, and other *Dipterocarps* do not successfully attack living healthy trees.

Shothole and pinhole borers, fam. Scolytidæ and Platypodidæ, represent a class of borers which are characteristic of Indian forests, as also of most tropical and semi-tropical forests, and which are comparatively absent from European and North American forests. Conifers and oaks in the mountain forests and practically every

timber species of economic importance in the deciduous and evergreen forests are subject to attack by shothole and pinhole borers. The Sal, for example, serves as breeding material for at least 27 species of *Xyleborus*, *Progenius*, *Diapus*, *Platypus*, *Crossotarsus*, etc. As far as the writer's observations go they are all to be classed as pests of secondary importance; the technical damage done is very considerable, but the attack is confined to dying and unhealthy trees. In 1911—14 considerable mortality in the Sal forests of Bengal was assigned to *Diapus furtivus*, Samps., fam. Platypodidæ, until investigation showed that the species was present in only 16 per cent. of the dead trees, and that the shot-hole borer attack was secondary to that of a root parasite, *Polyporus shoreæ*. Again in the Sunderbans forests of Sundri, *Heritiera Fomes*, an epidemic outbreak of *Crossotarsus squamulatus*, Chap., fam. Platypodidæ, which occurred with all the appearances of a primary outbreak, was found to be limited to trees possessing diseased roots. Heart-wood borers of the families of Cerambycidæ and Lamüdæ (Coleoptera) and Cossidæ and Hepialidæ (Lepidoptera) are common pests of the more important trees, but it is doubtful if any are normally capable of killing off forests over large areas. The teak during the first few years of its life is attacked by a lamiid, *Haplohammus cervinus*, Hope, and the hepialid *Phassus malabaricus*, Hmps., which produce cankerous and distorted growth in young saplings with galleries in the heart-wood. Young *babul* (*Acacia arabica*) is attacked by a lamiid, *Cœlosterna scabrator*, F., while numerous other trees now grown in plantations show similar attacks in the sapling stage. In plantations of these trees repeated attacks are often serious enough to cause the death or stagnation of a large proportion of the crop, but under natural conditions the activities of the pest have never been sufficiently conspicuous to cause comment.

The Sal is not attacked by heart-wood borers in its youth but trees over 2 feet in girth suffer serious technical damage from the larvæ of *Hoplocerambyx spinicornis*, Newm., fam. Cerambycidæ. Normally this species breeds in dying or diseased trees. Under abnormal circumstances it may assume the character of a primary

pest, but its rate of increase and dispersion is so slow that it can be easily controlled. In those Bengal and Assam Sal forests where a generally unhealthy condition of the soil prevails, the proportion of dead trees infested by *Hoplocerambyx* has not exceeded 40 per cent. in an observed period of three years, although the borer is endemic in the area. In a recent local outbreak of this species in United Provinces Sal forests the number of living trees infested in the sixth year of the attack is less than 30 per cent. of the whole crop, and the area affected under 2,000 acres.

The teak is attacked from the young pole stage to the end of its life by a serious pest, the beehole borer, *Duomitus ceramicus*, Wlk., fam. Cossidae. The heart-wood of the living tree may be riddled with galleries an inch in diameter without affecting its vitality; in fact the average teak tree reveals nothing of the activity of the beehole borer until it reaches the saw-mill.

Numerous other illustrations might be cited to show the absence in the forests of India of a primary insect pest which is capable of killing off vigorous healthy trees, or of devastating virgin forests over a large area. The principal pests of natural forests are purely of secondary importance, normally breeding in unhealthy or newly killed timber, and incapable of successfully attacking healthy trees. But it should be understood that the species in question are of secondary importance only in respect to their directly fatal powers. As causative agents of serious technical damage to timber, of loss of increment, of stagnation and malformation, they are admittedly of primary importance, and in this respect undoubtedly stand as high as the secondary pests of other countries.

This condition of inter-relationship between insect species and their hosts would appear to be normal on the one hand in strictly virgin forests, and, on the other hand, in ravaged forests which, under protection, are resuming a stable condition approaching the primitive. Conditions outwardly similar prevail, as far as it has been possible to ascertain, in the forests of the Dutch East Indies the Philippines, East and Central Africa, and the northern coastal belt of Australia.

The past methods of forestry in India have not favoured the development of forest insects to the stage of primary pests. The retention of the normal distribution and proportion of tree species in the growing stock prohibits extraordinary increase of defoliators, while the methods of timber felling and extraction do not provide facilities for abnormal breeding of borers.

As the majority of the forests now worked in India are irregularly stocked as regards species and age classes, and felling operations are carried out by the selection of small numbers of trees over large areas—a method which reproduces natural conditions more exactly than other sylvicultural methods—an abundance in any one locality of loppings, slash and unconverted portions of logs which serve as breeding grounds for borers is avoided. Moreover, extraction of the timber usually takes place within a few months of felling and at a period when the imaginal activity of the pest is lowest.

The objects of forest management in the future, however, do not tend towards the maintenance of the forest in its primitive natural condition but rather towards the elimination of economically worthless species, and the production of more uniformity in distribution and age of the valuable species. In several divisions already Working Plans are in force which are converting the original irregularly stocked forest into an artificial type of forest consisting of a series of even-aged crops with an increased proportion of the economically valuable species.

In forests of the uniform type fellings and regeneration operations are more concentrated both in time and in place and the danger of abnormal insect activity is thereby increased. It is in these forests and in our artificial regeneration areas and plantations that we may expect in the near future to find the existing secondary pests assuming under epidemic conditions the rôle of primary pests. But at the same time it is in these forests that control measures can be introduced on a scale more practical and efficient than at present possible.—[*Agricultural Journal of India.*]

PROGRESS.

We cull the following from a Notice in the *Rangoon Gazette* :—

GAZETTE OF INDIA.

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The following postings of Conservators are notified :—

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Mr. W. F. Perrée to the charge of the Fertilisation Circle, U. P.

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We congratulate the United Provinces on taking the bull by the horns and arranging to ensure fertilisation and reproduction which has, in the past, been so generally left to such unreliable agencies as wind, bees, etc.